OBSERVATION SURVEYS

DEVIL'S HOLE

1967-68

CAROL J. JAMES

Digitized by the Internet Archive
in 2017 with funding from
CLIR

https://archive.org/details/observationsurve00jame

CJJ
67-6 Carol J. James

C.J.J.

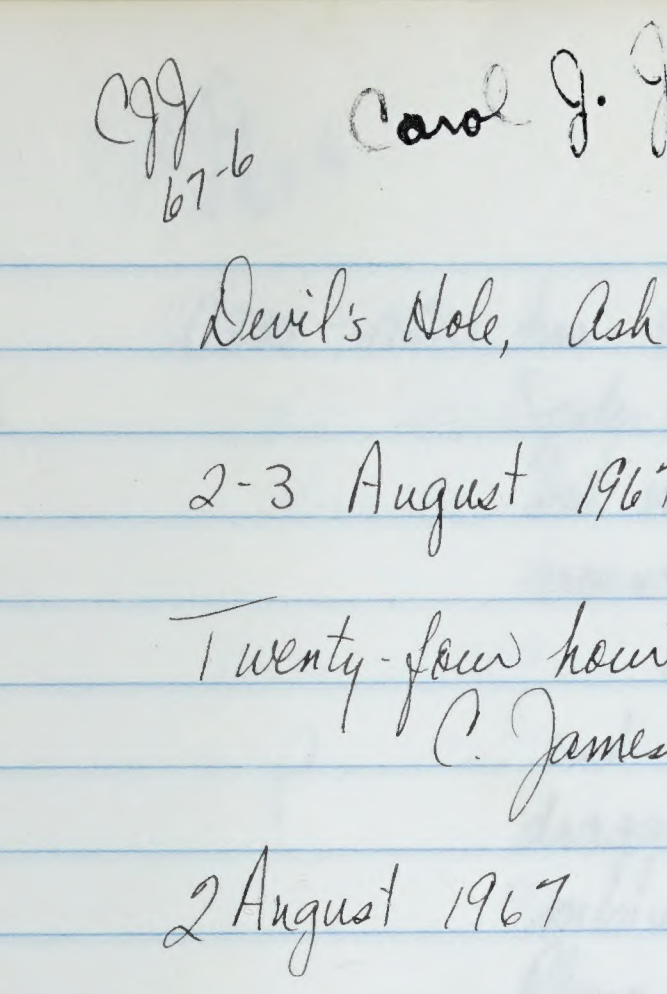
Devil's Hole, Ash Meadows, Nye County, Nevada.

2-3 August 1967 — 0330 hrs. (2 Aug.) - 0300 hrs. (3 Aug.) DST

Twenty-four hour survey — Observation Only
C. James & Steve James

2 August 1967

0330 hrs. — Arrived and observed until 0410:
Many fish on shelf (estimated 200)
with many of these adults. Area on
south section selected which can easily
be observed in detail throughout the survey.
This portion of the upper shelf is positioned as
shown and measures approx. 1½ x 1 feet.
It is designated as Observation Area I —
ObAI. 30-40 fish in Ob. A. I.
Some activity, esp. adults. Most
young inactive. Some fish seem
bothered by the artificial light.
These individuals hide in algae and
under rocks. Others not bothered.
No territory tendency among adults.
Young seem somewhat curious of
adults ("sniffing" around adults) but
at the same time wary of adults.
Some very young individuals seen,
but young not in preponderance observed
30 June & 1 July & previously. Some (but little)
feeding (nibbling at algae on rocks).



Water level 0345 1.90

CJ 67-6

0330 - 0410 hrs. (cont'd)

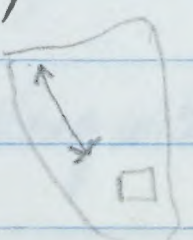
Spider activity. Beetles congregate at edge but inactive generally except for those around planaria. Planaria very active.

Planaria observed with its posterior end encircling alive beetle. The planaria dragged the beetle around for several minutes. Beetle seems to be weakening Planaria approached by another planaria which also encircled the beetle. Apparently eating beetle. Beetle covered with some kind of scum - appears to have fuel covered with cottony material. Also - several planaria (about 6) in a knot. This activity in very shallow water on rocks at south portion of shelf. Some planaria on bottom but especially on surface.

Scorpion found under rocks 5"
dormant until disturbed.
Bat activity.

Floating algae - small patch (see eaten) and two patches of coagulated scum & algae. Approx. 7" in diameter - floating with the scum. Scum present. Shifting. Clear on most of shelf momentarily.

Algae recovering now - only deepest portion (NW side) of shelf without much algae. But this area still quite large. Rest of shelf-algae as previous to 30 June 1967.



GG 67-6

* Estimates are made only of those actually seen. Not including young or small juveniles not actually observed.

0600 - 0630 hrs. Bees active

Scorpion which we had killed being devoured by ants.

Scum broken but still over entire water surface. Shifting constantly.

Water level (0615 hrs.) 1.86

Much fish activity. Constantly moving. Many large adults. Ob AI. - est. 60 fish. On upper shelf - est. 300 - 350 fish. Some males chasing others, but no territories observed. Will chase one for a distance, find another and chase it a while. Some behavior seems to be simple following. Feeding activity on algae and scum on surface.

Fish burying themselves in algae is prevalent.

Some beetles still at water's edge. Planaria much less active - few seen. Beetles also on rocks.

Much "play" (rubbing on rocks, flipping, etc.) by fish.

Some chasing of ♀s by ♂s but only for a short distance and then give up.

0630 - 0700 hrs.

Definite and widespread feeding on rocks (algae) and on scum at surface.

Individuals seem to swim along with the

shifting scum. Scum shifts as much as five feet in one minute. Twice during this thirty minutes, I could see (on the way out) ½ of the upper ledge (shelf) clearly. But this "tide effect" was only observed distinctly during this half hour. Most of ½ hr. all other times scum only shifts slightly - can be seen moving but clears in very few places.

One individual - feeding in an area where little or no algae (grey in appearance). It will stay back very slightly, then lunge at the bottom - repeated, forcing mouth area into ground.

Congregation of fish (up to 10 in a 1½ x 2" area) due to feeding? - this area was also grey & gravel like in appearance.

Both small (juvenile) and large individuals at surface.

Lunging feeding noted with other fish.

Little contact between individuals at this time (little "notice" of each other). Much "play" activity as described before.

Many males in population on upper shelf.

In Ob Area I - est. 55 fish at 0645 hrs.

Feeding apparently mainly at edges of algae - near bare areas and at bare (gravel-like) areas. Planaria very scarce.

Male chasing female (another male follows for ~2 sec. and then gives up) and after several seconds, he just swims in another direction - gives up also.

Attempted spawning (some "play" = courting display?)

Males swim alongside female, but no spawning. Much chasing and following behavior.

CJJ 67-6

Apparently random movement over upper shelf - fish cover wide territory. Males outnumber females. Some fish at times appear perfectly still. ~ 6mm young seen, especially around water-level indicator & extreme ~~southern~~ edge of shelf. Fish not easily disturbed.

Measurements (taken at 0645 hrs.)

O_2 - 0.6
O_2 sat. - 1.2 at 32.5°C

Light:
Black - 32.5
~~Red~~ Red - -23

Temp. Water - 33.6 °C
AIR - 87.0 °F

0700 hrs. Bee activity decreasing.
C. diabolis: Chasing frequent. Decline in feeding.
Small fish (male) (~13mm) chasing large female (~23mm) for quite a distance.
One large (~26mm) male exhibited what appeared to be limited territoriality over a small grey-colored area which was a favorite feeding area a half hour before. This behavior was directed almost exclusively to other males; females and young not challenged. Behavior only lasted approx. 1½ min. after I first observed (noticed) it.
Scum remains on top of water obstructing view. Since ~0630 has not shifted substantially.
0730 hrs. Water level 1.80
Fish in Ob. Area I = 4/5

CJJ 67-6

0800 hrs. -

Fish in Ob Area. I = 45
But - Apparently a gradual decline in fish over the entire shelf. Now est. 250.

0815 hrs. - Water over deepest portion of pool (NE corner) now free of scum. Occasional ripples observed over there - as those created by fish at shelf nipping at scum & surface, but this could be due to insects or many other surface.

Perhaps this is due to the interference of the scum, but it seems that the number of individuals will vary from 5 min. to 5 min. even in the Ob Area I. For example, at one time there will seem to be relatively few fish in the Area and I will proceed to re-evaluate my estimate in Ob Area I. But 5-10 min. later, there will appear to be many fish in the Area. This may be due to random movement, also. Or hiding in algae or under rocks.

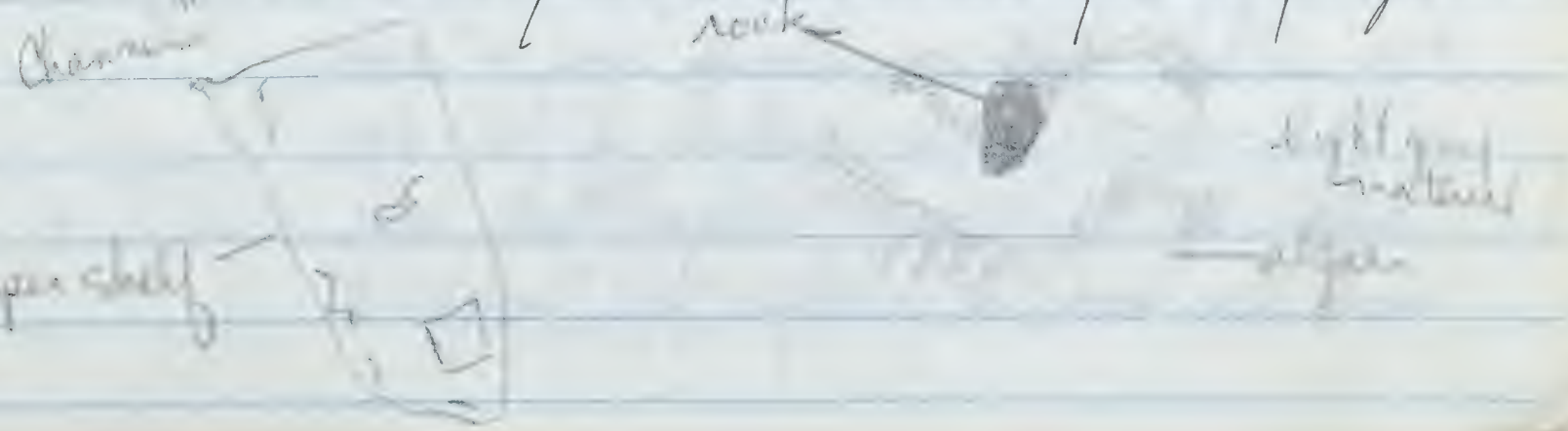
The Ob Area I at times seems to have a denser population (at least in adults) than most other areas of the shelf. This area has a heavier growth of algae than many other places. But not more than the SE corner, which I can also see well.
* Again, I can see little of the North-West corner of the shelf.

CM67-6

The floating algae evidently grew again from the sides of the rock edge. Since the water level is so variable, algae and mud are seen to be deposited on the edges - evident especially at "low tide." The algae that is now "floating" grows from a portion of the rock wall and, as the water level lowers, is draped over the rock so that the patch appears smaller.

0835 hrs. — Bees - no activity. Small water striders seen.
Water level - 1.77
Beetles near water's edge, but not in numbers seen before.

The areas which I previously recorded as appearing grey & gravel-like and being somewhat preferred as a feeding area, may (from observation of a small area on the extreme southern border - v. shallow 2-3") be areas of grey organic debris of some other substance exposed by the fish.
These areas are relatively few on the upper shelf and have not been noticed before. See map for positions. They are very much like channels and the fish often follow them in swimming. They resemble pathways in that they make S-shapes around rocks and other obsticals but also may turn while evidently in only algae.



GG 67-6

0900 hrs. – Floating algae in water forms large bubbles – up to 1½" in diameter as if gas being released under it.

0910 hrs – Water level = 1.76

O_2 – 0.8
O_2 sat. = 1.2 at 33.0°C

Light:
Black – 56.0
Red – 10.0

Temp. Water – 33.5°C
AIR – 91.5°F

Est. of fish in Ob. Area I = 30-35
Est. on shelf = 100-150

0930 hrs. – Bees active again.
Still some (but infrequent) feeding.
(still lunging & butting head against surface of bottom)

0940 hrs. – Pair seen spawning. From time first seen, swam side by side with ♀ appearing to lead evidently (appearing to) "picking" sites for laying. Pair spawned many times and covered a distance of ~ 15 ft (straight line distance – of course random swimming covered more feet) See map. Pair did not break up until pair encountered a group of many males & some females in fairly shallow (~10") water at the southern portion of the shelf. Then, they (pair) completely separated. No attempt to rejoin (light reflecting on scum and scum

itself obscured actual details of break (camera etc.) but break was very quickly executed). The pair stayed together 2-3 minutes since I first noticed them. Eggs deposited almost exclusively on rocks. Males press females only lightly to rock - eggs would probably be on top of algae covering of rocks.

0950 hrs. - Some fish still at surface. Still some feeding. ~100 on shelf.

1015 hrs. -

O_2 - 0.7 Temp. Water - 33.8°C

O_2 (sat.) - 1.1 at 33°C AIR - 94.3°F

Light : Black - 64 (loose connection)
Red - 18+

1025 - Water Level 1.76

Fish in Ob. Area I - ~20-25

Individuals on shelf becoming quite sparse. Still fairly abundant in Ob Area I but does not seem to be typical of rest of shelf - except for other heavily algaed areas.

Large Male observed on large rock - flaring fins & evidently attempting spawning with each of five different females. But all females turned away.

Gray, gravel-like area next to Ob Area I still very well inhabited - Fish often follow the "pathway." Often playing (turning & twisting &

rubbing their sides) in the area.
In a nearby area which also is grey, two fish have been alternately chasing each other in a very small circle (2 1" dia.) for many minutes. Observed this activity before. Now activity has continued for 3 min. (while continuously observed).

It appears at further observation to be a feeding territory of some kind. It comprises a small space ~ 1x2" in which the algae has been cleared and it contains several crevices which I have seen several fish poke into it as if feeding. I cannot see in it - it is very small. One fish is evidently defending it from others - and one other individual in particular persists - & ∴ the merry-go-round.

Also observed another ♂ & ♀ swimming side by side - ♀ in lead again but no spawning actually observed. — Correction - What was very probably the same pair just returned from the northern edge of the shelf to the So. end. Some spawning but most of the activity was just swimming in tandem — looked like male was having difficulty keeping up. Course during time viewed - always in deepest water. See map.

Occasionally, one or a group of other fish (males) will try to interrupt (appears they try to join) the pair. Same as first pair noted.

C99 67-6

The feeding territory noted before (small territory, two fish circling) still maintained. Observed now for 20 minutes. Activity - two fish (perhaps same two all of the time) may feed in that area (pecking, lunging & shaking their bodies as they peck) but only for a few seconds. Then one tries to chase the other out - circling. Occasionally, a third fish may interrupt but major conflict between same two.

1100 hrs. - Spawning Activity.

One large ♀ & a large ♂ seen swimming in tandem - but not observed spawning. A small male (~16 mm) challenged the pair several times but they always "outran" him. The pair several seconds later came somewhat near again and the small ♂ again gave chase. This time, after the three fish swam swiftly together for several seconds, the large male was left behind. The small ♂ and large female immediately spawned several times and when they (after several seconds) came close to the large male, he again gave chase and the three went over the ledge. Small ♂ & ♀ returned.

1115 hrs. - Few fish on upper shelf.
Ob. Area I - 10 Upper Shelf - est. 50-75

But majority of these ↗ are spawning or attempting to.
Male usually advances, shows fins & swims near female. Then swims up to her. She swims, but this is either quickly away (rejection) or so he can stay with her.

Some feeding. Large male seen apparently tearing (with a quick movement and jerk) algae off rock. Not unusual to see sm. ♂ & large ♀.
In one instance, ♀ & ♂ at surface ~~at~~ ♀ nibbles at scum & swims around ♂, occasionally approaching ♂. Every time she comes close & nudges him, he swims a short distance. Repeat.

Slight schooling., especially when frightened.
Feeding territory commented on several times before - maintained now 1 hour. Still circling.

Algae in other (large) grey area cleared further away (duty activity) but in other grey areas where there has not been good activity, the algae has begun filling in.

Spawning in areas of good concentration of algae - as many as 4 ♂ trying with one ♀.
Additional spawning in areas - see map.

CJJ 67-b

1130 hrs. – Cloudy now. Total cloud cover.
Before this time, sunny.

O_2 - 0.6
O_2 sat. - 0.8 at 33.5°C

Light: Black 87
~~Red~~ 40

Temps.: Water 33.7°F.
AIR 97°F

1145 hrs. – 50-75 fish on shelf.

1245 hrs. – Sun covering ⅓ of shelf
Some attempted spawning. Feeding (tearing algae on rocks). Beetles no longer at water's edge.
Water level = 1.86

Floating algae appears larger (higher water level).
Still bubbly in appearance.
Saromalus seen.

Small male following female. Female crossed light meter cord. Male stopped and hesitated before following.
Still 50 fish on shelf - seem to frequent deeper waters - now away from Ob. Area I.

1255 hrs. – Sun shining on ½ of shelf.

CJJ 67-6

1255 hrs. –

O_2 – 0.5
O_2 sat. ——

Light: Black 88.5 (meter not in direct sun)
~~Red.~~ 46

Temp. Water 33.8°C
AIR 102+ °F

1305 hrs. – ~40 fish on shelf.

1340 hrs. – ~30 fish on shelf

Observations: ♂ + ♀ swimming in tandem.
Female swam to the surface to break up the pair. Male left almost immediately upon nearing surface.
Many hide in algae.
Direct sun on ⅔+ of shelf.
Moderate activity of those on shelf – some feeding and attempt spawning and chasing. Some (but very few) at surface.

Bees – decreasing activity

Bubbles constantly coming to surface and staying on surface at so. end – also over all of the shelf somewhat.
Large Grey area filling in – others almost obliterated.

cJJ 67-6

1400 hrs. – Water level 1.92

O_2 – 0.5 (jumping – 1 initially settled)
O_2 sat. – 0.6 at 35°C.

Light: Black – 212
~~Red~~ – 139

Temp. Water – 34.0°C
Air – 107° F.

25-30

1500 hrs. – 25-30 fish of upper shelf
Sun shining to 45' level of Devil's Hole.
Shade starting on Western side of upper shelf
Scum still present.
Sky clear. Windy, gusts to 30 mph.
C. diabolis – fairly inactive. Larger fish predominately, and many o's nibbling at rocks. Breeding activity – two males attempt but without success.
Another two males meet - one does a "play" gesture to avoid the other and easily swims away.
Five or six males attempt spawning with several females - all repulsed.
Males show fins and some make quick gesture ("play"; dart).
Bee activity low (water level high)
Can hear bubbles coming from algae.
Algae covered with bubbles as is surface of water.

1520 hrs. – O_2 0.5+
O_2 sat. – 0.5+ (almost 0.6)

Light: (sun on probes)
Black 200
Red 117

Temp.: Water – 33.9°C
Air – 110°F

CJJ 67-6

1520 (cont.) - Shade covering so. end of shelf.
Water level ± 2.00

1540 hrs. - Scum appears very moist - almost continuous and quite stagnant except around rocks at so. end. Bubbles.

See map for position of Floating algae. - Noticed in several places - all along Western side.

Sitting at water's edge now, the scum (& that over the upper shelf region - the scum is shining over the other regions and some of the upper shelf region) and bubbles & light remind me of the humidity of a steam bath. It appears very hot and humid, although with the shade the air has cooled somewhat. Floating algae still bubbly. Scum filled with bubbles & can hear them coming to the surface from the algae.

I dipped a bottle into the water and its sides picked up some of the scum. It appears brown and light green (different substances).

67-6

1550 hrs. - Scum is quite green.
Vision is very obscured but there seems to be more activity on shelf -
Shelf now in total shade for first time since this morning. Everything appears very green - Bubbles cover algae and many on surface.
Two fish seen swimming in tandem - then vision obscured. Extremely difficult observing.
Seems to be quite a number of fish at the surface - five in one group seen, three in another - several single individuals.

1555 hrs. - Water level - 2.03

Smaller fish <13 mm also seem to be more abundant than in previous hours.

1600 hrs. - Seventeen fish counted at surface in Ob Area I. None on bottom. (remember - heavy algae in that area.)

1605 - 1610 - Three fish seen near bottom in Ob Area I, but none stayed. Still many individuals at surface of Ob Area I; at surface and around rocks and algae in other parts of shelf (where little algae).
Estimate on shelf - 100+

1615 - Many on surface. Even with limited vision, I could count in Ob Area I - 12 on surface and 6+ on bottom or in

CJJ 67-6

mid-water.

1625 - Thirty fish counted at surface water of shelf
Undoubtedly many more.
Estimate on surface of shelf - minimum of 40-45. Approx. 20 fish now in Ob Area I - decrease probably due to human disturbance.

1635 - Estimate on shelf 150-200
But vision still obscured.

1640 - Entire hole in shade.
Bubbles at surface

O_2 0.6 - (0.5-0.6)

O_2 sat. - same at 33.5°C

Light: Black - 56 Probe in shade
~~Red~~ - 8

Temp.: Water 33.7°C
AIR 104°F.

1645 - Fish still very numerous (count 50 fish, mostly in center of shelf - see map) at surface.
Planaria quite active; especially around rocks at south end. Some spawning attempts made by males - unsuccessful.

CGJ 67-6

1800 - 150 counted at surface of water
estimated 150-200 at surface
400 fish total on upper shelf (counted)
est. 500± on upper shelf
Note: these counts and estimates include only large juvenile and adults - individuals under about 14 mm total length not seen (whether because of distance & scum or because such individuals were not on the shelf at that time) and therefore not included in counts or estimates.
Many at south end - around rocks.
(seen eating planaria (3) - planaria not as plentiful as at 1645 hrs.)
No spawning or even chasing observed.
Fish stay together much but pay little or no notice of each other - no interaction.
Preponderance of males? Scum more broken.
Very few juveniles & young seen.

Position of Fish at Surface + Bottom

Position before any human disturbance

1815 - O_2 0.4
O_2 sat. 0.6 at 33.6°C

Light: Black 40
Red -10

Temp.: Water 33.5°C
Air 99°F.

Water level - 2.06

CJJ 67-6

Fish at surface relatively inactive. Stay at surface (again, slight schooling but little interplay between individuals). Relative little interchange between top and bottom feeders. Bottom feeders may average slightly larger and larger portion of top feeders may be males (i.e. - females may prefer bottom feeding at this time or excess males forced to top)

Very few small juveniles or young seen. But -
10 fish (sm. juv. + young) seen on west side of floating algae - between algae + rock cliff, separate from rest of population on shelf.
Activity - "play" gestures (rubbing sides against rocks) mainly feeding. Some but little chasing. 'Cord happy.'
Great majority seem to be males - Force excess (smaller ♂, etc.) to be top feeders?
Many relatively small but brilliant ♂ at surface

Observed to 845 - Beetle again beginning to gather at the water's edge.
Weather clear except for time noted previously.
Approx. 25 in A & Area I - Note - none on surface now, but may be due to human activity above the water.

1845 - Slight decrease in population on shelf?
Again, hard to be sure because of light (decreasing) and ocean.

1900 - Est. 425 fish on upper shelf.

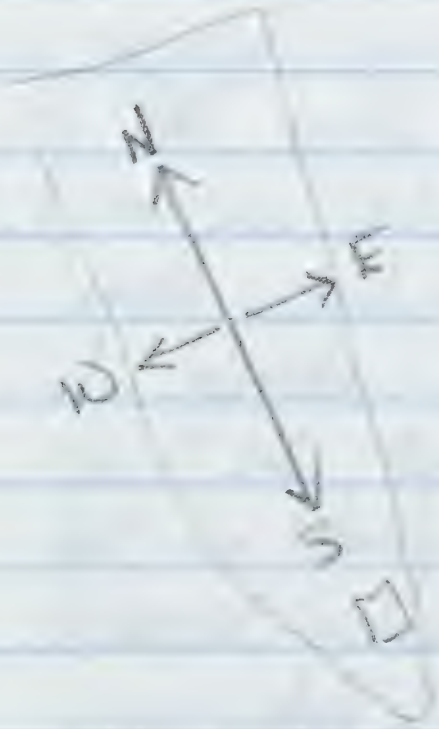
1935 hrs. - O_2 0.4
O_2 sat. 0.6 at 33.6°C

Temp: Water 33.7°C
AIR 97°F

Light - Black (-12)
~~Red~~ off scale (below)

1950 hrs. - Water Level 2.0'

2000 hrs. - Approx. 20 in Ob Area I
50 fish at surface in shelf area, but these were wider spaced - more single & not in groups.
Several smaller (young & small juveniles) seen



Entire water area, Devil's Hole -

Compass used

Note - many insects die in waters of Devil's Hole. Predominately ~~termites~~ flying ants and small white moths.

2040 - 2050 hrs. Many Adults seem to have disappeared! (I left from 2000 - 2040 hrs.) Now few fish on shelf and these are majorally small juveniles and young.

O_2 0.4
O_2 sat. 0.6+ at 34.4°C

Light Black -36
Red off scale (below)

Temp: Water 33.8°C
AIR 93° F.

2105 hrs. - Water level 1.98

2115 hrs. - Nearly all fish gone from shelf.
Ob. Area I - 2 fish (one juvenile, one young)

In all other areas on the shelf that I can see, with a detailed inspection (not comparable to other counts - I am looking for young)
* I can see only 10-15 adults and approx. 20 small juveniles and young.
This number is, of course, biased. I can count only those young and small juveniles that are fairly near me.
I cannot include the northern part of the upper shelf in any of these - distance does not permit even count of adults because of darkness. But, as far as I can see, there are very few adults in that area; I can
* see more. * I made a study of only approx. the southern most 2/3 of the upper shelf.

cgg 67-6

Note - all individuals, especially adults, went to lengths to avoid my light, ducking under rocks. They appeared to be inactive until my light fell on them and they immediately took actions to avoid the light.

Planaria very active. Very abundant on surface of water.

Young fish frequent surface. One young was at surface and was quite inactive when my light first fell on him. At the first 1 or 2 sec. he did nothing, but then became active, moved in several directions. When I followed him with my light, he started to spiral down to the bottom (one spiral in a jerk, split second wait, then another spiral).
An adult on the surface, when the light fell on him, went down at a steep angle to the bottom →.

2230 - 2250 hrs. - On southern 2/3 of shelf. Detailed count results in -

10 adults, 15 Juveniles, 16 Young

Again, please note that even adults on the northern 1/3 of the shelf may be missed - can be seen only when light causes them to move. But few objects in that area look like fish anyway. One adult seen over in that area.

Also, young over two feet away are easily missed.

Lighting affects accuracy. Scum broken but present. Many planarians on surface.

Activity - Adults inactive. When one adult initially exposed to light, it was completely motionless on a rock. It remained so for 3 seconds after exposure and then made a very quick movement in an attempt to bury itself in the very skimpy algae on the rock.

A Juvenile, at surface went immediately down to bottom

one young at surface - when exposed to light, random and somewhat frantic movement for about 15 seconds and then to bottom.

Another small adult, remained motionless for 45 sec. after exposure and then random movement for 2-3 sec.. for shelter, it then went in a hole in the water level device.

2305 hrs. - Water level 1.94

O_2 0.4

O_2 sat 0.6+ at 33.4°C

Light Black -38

~~Red~~ off scale (below)

Temp. Water 34°C.

AIR 94°F.

2330 hrs. - Almost same results on northern edge of shelf. I entered the water carefully and took three steps to the northern portion of the shelf - but actions taken were careful

not to cause the inactive fish to become active and disturbed.

Results of count at northern edge -
approx. 10 adults
20+ Juveniles
15+ Young

3 August 1967
0030 hrs. - fish in same proportion (approx.)

Seems to be a few more fish on shelf but may not be significant.

Between 2330 to 0030 - small but dark clouds (forerunner of storm) lightning on horizon. Wind came up - gusts to 45-50 mph. above crevice.
In hole area near water - gusts to 25 mph.
At 2345 hrs -- sky was still clear overhead.

Light Black -38 (light from flashlight)
Red - below scale

Temp: Water - 33.7°C
AIR - 90.5°F

O_2 - 0.4
O_2 sat 0.6+ at 33.0°C

Young and all other individuals at bottom - none seen on surface.

0230 - 3000 hrs. Fish in Ab Area I -
4 adults
3 Juveniles
3 Young

Fish on shelf very inactive. All on bottom.
I seem to be able to see more adults - at least in proportion to others - than at last observation.
Wind still very strong.
No clouds can be seen from the water's edge.
Beetles still along edge.
Planaria - sharp decrease in activity. Few at surface. Some on rocks.
Some fish (adults) appear to be slightly more active.

0300 hrs. — O_2 = 0.3
O_2 sat = 0.4 at 31.5°C

Light: Black = −40 (flashlight may influence)
Red = below & off scale

Temp: Water - 33.4 °C.
Air - 88 °F.

Water level = 1.98

CGJ 67-6

Upper Shelf Only

Depth Measurements taken at 0300 hrs. 3 August 1967
Water level = 1.98 on scale.

CJJ 67-14

Carol J. James

Devil's Hole, Ash Meadows, Nye Co., Nevada.

7 October 1967 0645 - 1920 hrs. PST

C. James & C. W. Ivy

We stopped at Manse Ranch Spring and put in ten fish traps before going to Devil's Hole for a 12 hr. survey. See Ivy MST #5.
Arrived at Devil's Hole at 0645 hrs. It had just barely gotten light - sun did not actually rise into view (over nearby mountains) until 0725 hrs.

Initial observations:

Weather. Very clear sky. Wind 25-30 mph above + gusts to 15 mph in "hole" area.
Algae - sparse but generally covering all of the shelf lightly. Grey places evident as before. No floating algae in weight.
Scum - very broken but "heavy" looking covering about ½ the water's surface.
Cage - scum covering ½ surface. Rocks + side with sparse algae.

0645-0700 hrs. - Fish - some (but little) activity. No feeding observed, just appear to be milling around. 50-75 C. diabolis on upper shelf. (7 in area). Some around the out side of the cage - especially the south end. Scum covering much of upper shelf surface.
Cage - can also see some milling activity in it also - as on rest of shelf.
Beetle + planeria - very inactive. A couple beetle seen on side of rocks, but not moving.
Two or three dead white moths floating on water's surface - nothing else.

CJJ
67-14

Light – sky clear
red – off scale
black – off scale
} there is light enough to see well – but 40 min. before actual sunrise here.

Temp.
air – 19.0°C
water – 33.5°C

Water level – 1.83
O_2 – 4 – 5 ppm (closer to 4)

0755 – 0815 hrs. – no wind. still approx. 50-75 fish on upper shelf.
Some bee activity + insects.
Some beetle activity – collecting on rocks.
Planaria still not active

Fish hide in rocks when disturbed.
Quite a bit of activity around cage. Eleven to thirteen adults observed nibbling at western + southern sides of cage (only sides visible). This is especially with reference to the southern side which has a little bit more algae. Fish like feeding in a group – first one group on southern + one on western side, then all but one change to southern side – 11 at once feeding w/in a 6" diameter.
No territoriality observed. If movement of a fish disturbed the others (most in a line while feeding), the entire line of fish would make (swim in) a tight circle one to three times and then resume nibbling at

CJJ
67-14

the same spot as before the disturbance.
The fish inside the cage can be seen only at about three at one time. They appear quite active and also nibble at the sides of the cage - one seen at the east side, two at the south side. Scum has shifted in the cage so that it is on the western half. Fish outside cage will go through the support cage to nibble at the small mesh inner cage.

Other fish on shelf - some feeding, some stationary (on bottom & mid-water) & some "play" (rubbing on rocks). Feeding not common except for those at the sides of the cage.

Note: One male (~ 23mm) w/ apparently good dark breeding colors was observed for several minutes probing into a crevice on the slope of the western cliff. He seemed to be trying to dig something out of the crevice & kept probing (violently) into it - sometimes hanging and for a long period vertical in the water. After several minutes, he left that crevice and wandered over a 5x7" area probing briefly into others. After planaria? ! - there was plenty of algae available without probing into crevices and I have previously observed planaria hidden in crevices in the rocks while inactive & they go especially deeply into the crevices when disturbed.

0820 - Light - sun up
red - off scale (below)
black - off scale "

Camera Light meter - held at top of water at rock
11.4

@ JJ
67-14

Temp.
Air - 17.6°C
Water - 33.5°C

O_2 - 4-5 ppm (closer to 4)
Water level - 1.85

0900 - 0915 hrs. - Wind coming up in gusts : → 35 mph. above + to 10 mph. in "hole" depression.

Activity - as described 0755 - 0815 hrs.
Feeding more intensive in those on upper shelf in area away from cage but slightly less intense in those feeding at side of cage. These individuals formerly in a group, now are more dispersed and wander frequently instead of intensive feeding.
Still 75 individuals on upper shelf.
(these are mostly adults, but also many juveniles and young).

as previous proportions at 0700 + 0800.

Light
Black - 2°C
Red - below scale

camera Light meter (held at water's surface)
11.6

Temp. -
Air - 22°C
Water - 33.8°C

Water level - 1.87
O_2 - 4 to 5 ppm (nearer 4) & by tint of preparation & now decreasing nearly 4.

7-14

1000 - 1100 hrs. -

Seems to be no change in number of fish on shelf - still 50-75 (varying activity during a 15 min. period)

1000 hrs - Temp:

Air 23.5°C

Water 33.8°C

Light

Black - 7°C

Red - below scale

Light meter - incident: 12.0 (taken w/ meter facing out from water)

reflective: 5.3 (taken w/ meter facing water)

O_2 - not taken

Water level - 1.87

Some chasing now as well as feeding.
Observed a juvenile chasing a large adult ♀

Cage - All five fish in cage & healthy.
Much chasing in cage and some spawning?

Cage Observations: One fish chasing another, then a third fish intercepted and started chasing the second fish (the one which had been after the first). These two then went round & round in a tight circle for 5 times, then broke up & went separate ways.

Over and over again during the 1000 - 1100 hr. period, this was repeated - resulting in almost constant

GG 6-14

conflict. This is probably vigorous competition between the four males for the one female. It appears that the fish that is being consistently followed (but not actually fought with) is the female for it is slightly lighter than the other four. Normally, the fighting is between just two males, but occassionally, it will involve three or even all four and frequently take the form of this swimming around & around in a very small circle. Indeed, the female at times seems to deliberately cause these conflicts by repeatedly leading a persuing male toward another male.

What we believe is spawning has been observed several times in the cage. One incidence - a pair went round and round in a tight circle near a rock - apparently using the cage mesh to spawn on - they went in a tight circle, stopped (with the male depressing the female laterally), again circled together, and stopped again. Another pair was observed to swim under a rock after some chasing - spawning?

Other parts of the upper shelf - Chasing on shelf fairly frequent.

(1050 hrs) Count 50 fish on shelf - mostly adults.
Est. 80 "

Bat out at 1050 hrs.
Some beetles on rocks
no planaria

(1055 - 1100 hrs.)

Light

Black - 7.6
Red - below scale

Camera light meter

incident 12.2
reflected 5.8

cgg 67-14

O_2 - 4 to 5 ppm (every year 4)

Temps.

Air - 23.8°C

Water - 35.0°C

No wind - still clear

High competition in cage much more movement than on rest of shelf.

(1100 hrs.) - Two fish swim in tandem and momentarily hesitate at side of cage (about 1' from bottom). They swim length of cage in tandem and then turn to double back & break up.

Again, 3 & 4 fish fighting at once - two go in circle, then two more.

1200-1230 hrs. - Count 30 + estimate 40 on shelf. Shelf quite deserted in most areas except for group around metal water measurer and group of about 15 around outside of cage (still some nibbling). some fish also over NE sloping rock of shelf - can see very few in deep water of shelf.

(1220 hrs.) - Water level = 1.87

Temp.

Air - 25.8

Water - 34.6

Light probe (shadow)

Black - 13.7°C

~~Red~~ below scale

O_2 = 4 ppm

Light meter

incident - 12.5

reflected - 6.5

CJ 67-14

Sun 5-15' above surface of water on western wall.
Bees active

Female C. diabolis was chased by a male for quite a distance - 3+ ft. until female passed by another ♂ + two males then fought for about ½ minute - around + around, break up and then around + around again - until female swam between them - breaking up the fight.
One male tried to follow her but finally gave up.

Planaria at water's edge.

1400 hrs. - 1430 hrs. :

Sun over 7/8 of shelf
Counted - 31 individuals on sunny portion of shelf. only ten of these were in direct sunlight in the middle of the shelf and eight of these are pairs (chasing) (six of these are on NE sloping rock of upper shelf). Many fish remain at the shelter of the below-water overhanging ledge of the western cliff. This ledge afford some protection.
10 Individuals in shaded ⅛ of shelf.
Est. 50 on shelf

Some bubbles to surface
O_2 - 4 to 5 ppm (closer to 5 ppm)

Light probe - in shade
Black - 25°C
~~Red - below scale~~

CSS 67-14

Light meter

	In shade ~~of~~ shelf	In sun
incidental	11.2	14.5
reflected	8.2	9.6

(much reflection off "hole" cliff walls)

Temp. —

air - 29.5°C

water - 34.8°C (check + rechecked w/ adjustment on O_2 machine)

Water level (1415 hrs. 1.86

Bee activity very high
Planaria in mid water

1430 - Sun full on shelf (so. portion in some shadows) can see down to 50'.

1500 - Sun completely off upper shelf - shadows.

1525 hrs. - 1550 hrs. — Count 50 fish on upper shelf - estimate 75. Some chasing but mostly feeding. Group of 11 adults on extreme NE portion of NE sloping rock of upper shelf.

Cage - some chasing but significantly lessened activity and competition - feeding now.

Still bee activity

Complete shade on water 1510 hrs. Shade now but much reflection off the walls.

cgg 6714

(1525 hrs.)

Temp.
Air 28.0°C
Water 34.5°C

Light probe
Black - 13.3°C
~~Red~~

Camera Light meter (held 1' from water)
incident - 12.8
reflected - 7.1

Water level - (1525 hrs) 1.88
O_2 - 5 ppm

1640 hrs. - 1655 hrs.

75-100 fish on shelf. Feeding.
One or two fish at surface - all others at bottom except for those at cage. Those feeding at cage: 8-10 again mostly at south end. Some chasing - slight schooling while feeding.
Bee activity lessens
Planaria - little activity

(1645 hrs.)
Light Probe:
Black - below scale
~~Red~~

Temp. -
Air - 29.0°C
Water - 33.5°C

Camera light meter (1' from water)
incident - 11.5
reflected - 6.1

CG 6714

Water level - 1.89

1710 - 1725 hrs. -

Planaria very active.
Planaria & Beetle seen in conflict - brief & only in that beetle seemed to attack planaria once.
Eleven fish "school" over grey area near rock at water level measure - these fish all frequented an area of ~5 x 7" and all were quite large (20+ mm). constant butting & hard nudging although no territory could be identified - just constant milling & butting & shovings & biting at posterior portion (fins?)

Count 80

→ (1715 hrs.) 100 fish on shelf. ~10 planarians devouring a dead beetle (encircling).

Cage - one fish swam to rock & suddenly disappeared - in "plain view" - by diving under the coat of algae on the rock

Beetle copulating on rock - three pairs on same 3 x 5" rock. Position: One on top of the other's back.

Conical snails observed.

1800 - 1820 hrs. Count 50 fish but inaccurate count of fish on shelf because of insufficient light. Estimate 75 fish. Feeding but not intensely, some

CJS 67-14

chasing. (But I have not observed actual spawning on the shelf all day.) Young + juveniles quite x abundant.

Cage - Still much competition in the cage. Somewhat decreased activity over entire shelf.

Temp.
AIR 27.5°C
WATER 33.5°C

Light probe - off scale

Light meter (1' above surface)
incident - 9.1
reflected - 4.8

O_2 - 3-4 ppm (closer to 4 ppm)

Water level 1.91

1910 - 1930 hrs. - Dark now (light enough only to see images in hole no reading on light meter.
No wind - sky clear.
Crickets chirp.

Planaria very active.
Beetles abundant at water's edge.
Fish - inactive, more young now than seen during day + proportion to juvenile + adults very high.

Counted those possible around the rocks at the southern end of the shelf (flashlight used)

CGG 67-14

Count: (including the first 4' of the southern portion of the upper shelf)

16 young -
8 juvenile
3 adults

Young - in this case in shallow water no more than 1½' deep. The proportion of young to juveniles & adults may lessen as the shelf water deepens, but I saw also observed young in deeper areas - a count of these would be very inaccurate because they are very difficult to see even up close. Several 5 mm young seen.

All fish generally inactive - two fish noted to come up & rest in ½" of water on the rocks I used to stand on for observations (rocks in mid water next to water meter).

Estimate - 20-25 adults and large juveniles on shelf. Large # of young & small juveniles.

Temp.
AIR - 25.8°C
Water - 34.2°C

Light - no registration on probe or meter.

Water level - 1.92

O_2 - 3-4 ppm

Leave Devil's Hole - 1920 hrs.

CJJ 68-2

Carol J. James

Devil's Hole, DVNM, Ash Meadows, Nye Co., Nevada.

25 January. 1968 0630 - 1830 hrs. PST

12 HR. SURVEY

C. James. & Steve James
(M. Armstrong + C. Schumaker at 12hr. survey at Schoolhouse)

Initial Observations -

Weather: Clear sky (w/ clouds scattered at horizon). No wind. Fairly cool - ~ 45°F.

General Condition: Scum over entire water's surface - fairly heavy but broken in little pieces and can see through to count fish.
Algae - Sparse as previously, but rocks seem to have more algae than previous few times & green tint is deeper.

0630 hrs. - arrived - just getting light
Water level - 2.05 - high

Planarians & beetles active.
Beetles - on rocks at water's edge
Planarians - very active - in mid-water (at scum?) and very abundant on rocks at water's edge. Many in water. Both large & v. small individuals

CJJ 68-2

0635 hrs. – incid. 3.6
reflected 0

Count 11 fish in 3' radius of me (at rocks at extreme so. end)
3 - small juveniles
3 - large juveniles
5 - small adults

This is biased, however, because I count in shallow water.

Cannot see north half of upper shelf well
So. half – count 20 est. 25 active
On all of upper shelf – est. 40 active
(can see NE rock and no activity there – there are so few areas of no. half that I cannot see well enough to est. – that I est. 40 on shelf are active.)

Fish shy away from light. One fish seen and when light shone on it, it ducked under some rocks and did not come out as I watched for ~30 sec.

Two fish (small adults) seen swimming together – observed one following the other closely for about 45 sec. – 1 min; followed, then slowly both went around in a circle (↻) and then same one followed the other for about 2 sec. + then slowed and stopped.

Bees, spiders, + small insects on water (dead on surface)

0650 hrs. — Scum is shifting + breaking in swirls over the extreme N part of the water's surface and along the N edge of the upper shelf and along W edge of deep water.

Current breaking by coming up or down at these points?

0655 - Water level 2.03 More rock to stand on!

of clear water

Now swirl at N edge of upper shelf.

0700 hrs. - Markedly increased fish activity

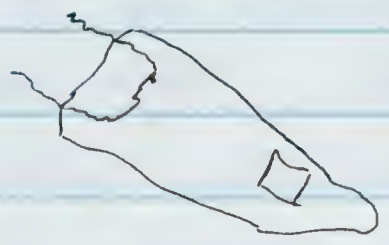
Light $i = 8.7$
$r = 3.2$

(Cage - fish very active. I can see all 5 fish at once - all chasing.)
Count 26 fish in area (3' radius) that I counted 11 in at 0635 hrs. Almost all adults. - seems to indicate hiding in rocks. Very reactive to flashlight which is still needed to see and count fish.

very quick negative response.

Could see many fish on shelf but could not accurately count so I dispersed the scum (by splashing) and many disappeared (probably in the rocks) - those left immed. after this scum dispersal were feeding (on falling scum?)

0708 hrs. — Swirl position:



0710 hrs. - est. 75-100 on shelf

↑ shifting scum + light make hard to count.

Activity is now limited to almost all adults. Some come to surface much "following" as if preliminary to spawning.

Much activity - swim in bursts + for long distance — → 2-2½' at a burst.

0715 hrs. - Beetles seem to have decreased some in activity. Planarians perhaps so.

Large bubbles (diameter = ¼") scattered over water surface (from my splashing?)

0720 hrs. - Water level 2.02

Light i = 9.2
o = 5.0

0730 hrs. — O_2 sample taken
Water sample taken w/ Van Dorn +
Winkler method used -
Titration in lab later
O_2 = 4.3 ppm

CJJ
68-2

0730 hrs. – Activity has decreased somewhat hard to see because of scum and reflected light. Still est. 75 active (in view) on shelf.
Several juveniles are also visible now.

0820 hrs. – Water level 2.01
Light i = 11.5
r = 6.0

Planaria and beetle activity at water's edge + surface has decreased markedly
Scum over entire water surface
Sweil:

Bubbles still at surface
Approx. same # (75) on shelf as at 0730 hrs. and activity seemed to increase after 10 min. of watching perhaps because I frightened them initially.
Last saw signif. cant feeding at 0825, then activity seemed to increase and this following (seen before during spawning & after spawning season) is not uncommon – this is not just casual following as one f would another, etc. but makes me expect them to spawn. – Following is not quite that

@JJ 68.2

rigorous, however, and no real attempt to push against rock - leading individual does not attempt to pull away quickly. Not - individuals all appear fairly dark. Many adults, and many of these seem quite large (~23mm).

I may say that there seems to be more large adults on the shelf than on other trips recently. Some adults at top.

0852 hrs. - the number visible seems to have suddenly decreased in the last 5 min. while I watched -

Light $i = 12.1$
$\wedge = 6.7$

Count 10 + est. 25+ on so. half of shelf
Est. 50 - 75 active +/or visible on shelf
fluctuate

Except for seven small adults and large juveniles around NW side of the USGS water level measurer where light is less intense because of shielding by the top

At this point (where fish are)
Light $i = 9.4$
$\wedge = 6.0$
(I was careful not to shield the light meter)

0910 hrs. - dispersed scum over shelf -
est. still - 50+ active on shelf

CJJ 68-2

0920 hrs. - One small adult - seen lying on the light substrate for that I know of 4 min 45 sec.
No moving of pectorals - just very still. No movement when fishes approached. - then slight move (into substrate) by itself - then 1 min. 15 sec. of motionlessness again - then move + paddle for a few seconds (disturbed by other fish?) - then motionlessness again - FOR over 14 min!

Later referred to as "The" fish

Some light (large) males
Ones exhibiting "following" behavior are darker

0935 hrs. - still 50+

activity decreased (fewer are active) very slightly except for "following" pairs.

Several "hovers"
Fish are concentrated over the light substrate and 6-7 around the USGS water measurer

"The" Fish - hovered around and attempted to settle on substrate several times but did not - now is back on substrate, no pectorals moving.
Appears to have white head w/ dark eyes prominent.

Bubbles on water are now yellow

0950 hrs. — Still 50+ fish on shelf

Light i. = 12.2
r. = 6.8

Water level — 2.00+

Activity - same

NOTE - no feeding on cage as observed during late summer
Under the cage is a frequent hiding place

Neither other fish nor my movements disturb "The" Fish.

Five planaria (all active) on rock top now (at which I stand) — significant decrease in activity &
Decrease in beetles, too - 15 now on rock surface, but these are almost all motionless.

0958 hrs. — After 15 min. "The" fish has changed posit ion but is still motionless and has been virtually all of that time - I have watched closely.

1000 hrs. - Activity over shelf NE rock is high - chasing + feeding.

Adults seem to have retreated from the so. half of the shelf to the NE portion.

CJJ 68-2

1000 (cont'd) Count 13 Adults in so. half
5 of which are around water meter.
Count 9 juveniles in so. half.

Count 17 Adults in approx. 2 x 1' sq.
on NE rock

"The" Fish - disturbed, I think by another fish.

small Rock slide? - evidences of one recently

1025 hr. - count 20 in so. half of shelf
8 of these are good-sized adults (19+)
in the 2x1' sq. area on NE rock -
now count 6 - feeding predominates
now - almost no chasing.
Est. 50 on shelf.

Seeming decrease in # visible + somewhat in activity

NOTE - Cloudy now (light strato-cirrus clouds) causing light to change quickly, perhaps accounting for the seeming differences in #s seen + in apparent activity.

1030 hrs. - Light. i = 13.4
r = 7.4

Water level 2.02

1040 - Now 37 fish counted in so. half of shelf
17 of these are good-sized adults.

CSS 68-2

1040 (con't) Definite feeding everywhere on shelf (w/ some chasing).
Especially in NE rock & at light substrate. Lunge feeding.
NE rock - 3 fish in 2x1' area

Spurt of activity - one time many, then few. Try not to influence fish by my movements.

Planaria seem to show a slight increase - 29 on rock surface. Most (20) where I stepped in shallow part, though.
11 Beetles on rock - fewer.

1045 hrs. - Now 21 fish in so. half - 14 good-sized adults. Most are around the light substrate.
Most of the juveniles are quite inactive. Adults remain active although not as much as before.

1050 hrs. - 45 Counted on shelf
24 in so. half
Est 60 on shelf

Light i = 12.8
r = 7.1
Still feeding

1100 hrs - 5.0 ppm O_2 taken

1205 hrs. - Water level 2.0 c higher
Light i = 13.1
r = 7.8

One bee active

CJJ 68-2

1205 hrs. (con't)

Twenty-six (26) counted in 5a half of shelf
(11 good-sized adults, rest are
mainly medium + large juveniles)

Plus 8 adults at USGS water level measures
3 of these are good-sized,
rest are small adults
~18 mm.

34 in all

Light at water measures
(above pt. where fish are)
$i = 11.6$
$r = 7.7$

These fish are now at the western edge of the measures rather than concentrated at the NW side (as before) - measurements taken where fish are

only a shift of about 5-6 ft around measures

NW side now reads
$i = 9.9$
$r = 6.9$

no fish now

Est. 50-60 ft shelf

Feeding is very evident.

(One fish came up on the rock I was standing on when the water covered most of the rock and I observed it feeding - nibbling on algal covering [bright green but only thin layer] of rock - no attempt or attention paid to planaria or beetle.)

CSJ 68-2

1235 hrs. – Planaria (some tiny ones seen)
10 on rock – active but few in #

Beetles – 5 on rock – inactive

Scum complete again & shifting.

1240 hrs. FEEDING. Intensive.

Practically every fish is either feeding or stops to feed. No spawning – follow activity now some follow but only casual & in groups of 3 usually – just mill.

Light i = 14.1
r = 8.5

1245 hrs. – 27 Planaria on rock – evenly distributed at water's edge.

(1225 hrs – "The" Fish ? – fish at almost same spot (w/in 3" dia.) on light substrate. It lays motionless w/out moving pectorals for several minute until a smaller fish disturbed it – then "The" plunged itself into the substrate & then lay motionless half covered w/silt for ~ 5 min.
Seen 3 min. later on top of substrate in same position but this only lasted 2-3 min. & then disappeared.

1255 hrs. – Feeding over entire shelf

CJJ 68-2

Fluctuation

1300 hrs. — 17 fish in so. half of shelf
10 are adults, 7 are juveniles + perhaps small adults (→ 18 mm)
Shelf - Est ~50

Light i = 14.0
r = 8.3

Water level 2.09

At water measurer - now 10 fish (adults - medium + some small)
Light over conc. of fish
i = 12.5
r = 8.1
West side again

1310 hrs. — Activity of fish in cage is greatly reduced - I can see 7/8 of the cage + I can see only one fish swimming at a time (→ a minute) may go by that I cannot see any.
One fish seems to be active, (the mats of dark algae prevent seeing everything) and I have seen it "scare" up one other fish once - so that two fish were visible at the same time (for ~ 5 sec.)

No, now I have seen two fish separately swim about ½ the length of the cage - in opposite directions. Activity intermittent + very low. (haven't seen a fish for over a minute)

1320 hrs. — 14 fish in so. half
8 are adults
except for those around water measurer see p. 14

Some feeding but not nearly as much as

CSS 88-7

before.

Around water measurer

11 sm. & medium adults at western side of water measurer

Light $i = 12.5$
$r = 8.4$

1325 hrs. — on shelf $i = 13.5$
$r = 8.1$

Fish flipping in substrate
~40 fish on shelf

1330 hrs. — First seen on water - extreme NW edge of Devil's Hole

1350 hrs. — Count 10 fish on shelf & 7 on west side of water measurer

Shelf $i = 13.9$
$r = 8.3$

Measurer (above fish) $i = 12.1$
$r = 8.1$

Est. 35-40 fish on shelf

Water level = 2.09

Bubbles are yellow-green

~20 Planaria on rock
12 beetles - inactive

average overall Est. 45-50 1400 hrs.

1410 hrs. — Still feeding Est. 60 fish on shelf
Feeding esp. over NE rock

CJ 68-2

1415 hrs. —

Shelf	i = 13.3	Measurer (6 fish)	i = 11.5
	r = 8.1		r = 7.8

Light never directly hits shelf. Comes close at west side.

1420 hrs. — Activity in cage increased slightly. Almost always can see one fish, + can frequently see 2 or even 3.

Stop most of feeding on shelf ?

1415 hrs. — O_2 taken (5.0 ppm)

1433 — Sunlight off water entirely. Clavaria + beetles as before.

1515 hrs. — Water level = 2.06

1525 hrs. — 18 or so. half of shelf and plus 2 at water measurer All but about 5 of these are adults. Used light to see as much as possible.

Shelf	i = 12.5	Measurer	i = 10.5
	r = 6.8		r = 6.5

Cage — 2 prs. following ?
Activity in mid-water — 4 visible at one time normally.

Shelf — Some feeding. Some following. Some at surface - esp. near NW side of

Cage.

Est. 50 fish on shelf - decrease in activity (over morning). (Increase over period immediately preceding)

1540-50 hrs. - Raise cage. Disperse scum.

Yellow-green bubbles - small & in islands of many small bubbles around one or two large ones.

"Snow" on rocks
↖ fallen scum

* 6 ADULTS CAN BE SEEN in the cage (did not enter today but probably at high tide sometime in last two weeks). - All fish in cage are now milling at mid-water.
Schooling seen (5 out of the 6 in one large group)
Following - Again, 2 prs. -
Extra fish is ♀?

1600 hrs. - Light i = 12.5
r = 6.9
Reflected light makes light increase

22 fish counted in so. half of shelf - now no scum (dispersed) - good light & can see well.

As I watched, fish (esp. juveniles) seemed to "come out of the rocks"

CJJ 68-2

Est. 60-65 active on shelf.

Feeding w/very occasional following before light increase!

1600 hrs. — Water level 2.04

1602 hrs. — 60 fish counted on shelf - est. 75-80. Still only a little scum so good visibility.

Light

shelf $i = 12.9$ measurer $i = 11.0$
$r = 7.1$ $r = 6.7$

1607 — ~ 10 planaria on rock
& 2 beetles — very active.

Note - scum as protection during time of highest light?

1615 hrs. — Feeding (at light substrate mostly) and much "swimming around."

Five or more at surface - esp. around cage. Those in cage staying below mid-water.

1617 — Light $i = 12.0$
$r = 6.4$

CJJ 68.2

1626 - Count 40 + est. 60 on shelf now

Light $i = 11.6$
$r = 6.1$

Feeding on NE rock. Some flipping (now 3 visible in cage at one time) in and out of rocks.
Water level - 2.02

1630 hr. - 5.2 ppm O_2 taken

Flashlight used to count fish in order to improve accuracy. (although not yet dark)
Darkling beetle dead in water.

1650 hr. - Water level - 2.00

Light $i = 8.7$
$r = 3.2$

Another fish ("The" fish?) seen resting on the bottom w/out moving. It is about 10" away from "The" fish seen previously. It Moved, then 10 sec. later was back again & rest.

Movements of all fish are slower.

Count 22 on so. half of the shelf
No fish around the water measurer

~4 in the 2x1' area on the NE rock
Est. 55 active
But this includes those I could see and I saw many fairly inactive in among the rocks.

Normally 1 or 2 visible in cage at one time - ~~almost~~ always at cage bottom
At least one ♂ is still light - large ♂

1705 hrs. - Planarias fairly active.
20 on rock

Beetles active + 44 on rock w/ beetle lined up + plentiful along the entire visible water's edge (along side)

1710 hrs. - Count 18 in so. half of shelf - good count w/ flashlight.

Est. 45 visible on shelf. Activity reduced.

Light - i = 5.1
n = <2

1720 - Large adult ♂ -

When fairly stationary, I shone the flashlight on him and he moved out of the flashlight light w/in 3 sec. Repeated procedure + results

were the same 10 out of 10 times.

Another experiment -
one 16-17 mm fish was very definitely stationary. Light was shone on him and he moved under a rock and out of the light in 11 sec.

13 fish counted on so. half of shelf
Light - i = 2 r = 0.

Flashlight used and detailed count made - flashlight moving over every inch of substrate but steadily and quickly enough so that fish would not be frightened and hide.

1735 hrs. - Cage 3 individ visible but all three were stationary. 3/3 very stationary. Two at west side and one on bottom of cage. Both very stationary individ. moved out of the light when shone on them - 8 sec. for one; 5 sec for another - light not as intense as above expt. source farther away.

CJJ 68-2

Cage - Another very stationary one - took 21 sec. to move. Then moved just outside light beam & stopped again.

Attempt at measuring intensity of flashlight light falling on water

Flashlight held at approx. the same distance (4½-5') and same ∠ of that when it was shone into the cage. Light was measured at the most intense point of the beam (& 1' above the water) (fish was located in the center of the beam when shone)

Light $i = 9.4$
$r = 0$
∠ of incidence

For light on those on shelf, flashlight was held ~ 1.5' from water & 1' from the water the light reading =
$i - 10.5$
$r = 0$

Light shone on it

"The" fish ? seen (2" from original place) perfectly still on substrate (no pectorals moving) after 8 sec, pectorals moved and after 10 sec, the fish jerked and after 12 sec (2 more sec), it tried to bury itself in the substrate. - there it remained unmoving until 30+ sec. count.

CJJ 68-2

later, light made him move.

1800 hrs. - No light Light $i = 0$
$r = 0$

Water level - 1.96

87 beetles on rock - very active.
Many at all water edges

56 Planarians on rock - active
Many planaria float on water's surface

5 Beetle larvae? also on rock
(in various stages - most dark)
Beetles seen copulating on rocks

1820 hrs. - Juveniles Adults
sm. large
4 5 5

Count on so. half of shelf

Five of these were in shallow water at the west of the rocks on which I'm standing.

Scum - little pieces but covering surface entirely.

No fish at USGS water measured

CJJ 68-2

Clear sky - no wind
Est. - 30

Wind only came up for ~15 min. at 1500 hr.
+ → 20 mph.

Beetle at insect remain

1820 hr. - O_2 taken (4.8 ppm)

1830 hr. - left.

CJJ 68-6

Carol J. James

Devil's Hole, DVNM, Ash Meadows, Nye Co., Nevada.

5 April 1968 — 0545 - 1855 hrs. PST

C. James & C. W. Dry — Daylight Survey

General observations:

Sunrise ~ 0530 but fairly light since 0510.

Completely overcast. Partly cloudy throughout the day - variable. Wind gusty to 25 mph. Oxygen not taken - chemicals unavailable.

See page 2 for scum & algae

Counts & estimates are on active large juvenile & adults - others cannot be seen easily (or not at all). Estimate allow for scum & dark background.

0550 hrs. - Counted fish active on shelf - 36
Est. 42 active

10 of these are at water meter

Light i = 11.2
r = 5.7

Water level - 1.98

Planarians & beetles fairly active

A Large dead spider is floating in the water and is covered with planaria

Dead moths in water -

CJJ 68-6

Scum - light and over entire surface - shift w/ wind. (see later - 1600)

Algae - very sparse. Some green at western water's edge + on trenches of NE sloping rock of upper shelf.

0605 - Now 12-15 fish (adults) around water meter - milling.

I watched the cage for one minute and saw only one fish active - he soon disappeared into algae mat. (I can see all but the extreme southern end - can see 7/8 of the inside of the cage)

0610 - Some feeding on NE sloping rock of upper shelf.

One large fish is observed to lay on the bottom (on the "taw matter" at the so.west portion ~1 ft. from me) - no pectoral motion.

0615 - Feeding increased now over the shelf + some chasing.
Feeding = lunging at rocks - no feeding at "taw matter"

0620 - Count 44 fish on shelf.
(30 in so. half + 13 at water meter)
Est. 60 active on shelf.

Light $i = 13.0$
$\lambda = 7.2$

0645 – 150-200 Planarians some "abandoning ship" from that dead spider.
Beetles not active

Fish – feeding + chasing + "play" against rocks
R not earnest

0650 – Count 54 active fish (34 in so. half of shelf - 17 at meter)
Est. 70-75 active
Amount of activity is increasing.
(Chasing + feeding increasing)

Light $i = 13.4$
$\lambda = 7.6$

0720 – Count 51 fish (as before - 34 on so. half - 17 at meter)
Activity as before.

Light $i = 13.5$
$\lambda = 7.6$

Water level = 1.97

0755 – Count 44 fish (29 in so. half - 10 at meter)
Est. 65-70 on shelf

Light $i = 13.5$
$\lambda = 7.8$

Appear to be less active – perhaps because now more intensely feeding

Seems that there are more juveniles (activity increased)
Count 6-8 now whereas 2 at 0720 hr.

these Juveniles are generally not included in counts.

Less than 50 planaria on rock (where I stand) + around spider - significant decrease.

0855 - Count 42 fish (~~49~~ 39 on so. half - 10 at meter)
Feeding Est. 65-70 on shelf

0900 - Light $\dot{i} = 13.5$
$\hat{n} = 7.6$
Water level = 1.96 on scale

9 planaria on rock - low activity
+ very low beetle activity
Fish - Still feeding + chasing
Activity (movement) slightly increased over 0755 +

0905 - I watched for one min. in the fish the cage + could see 5 of the 6 fish.
Some chasing in cage. Males appear dark.

0910 - Chasing increased somewhat - more earnest
Still feeding.

Sky clearing considerably. Wind still strong

(at 0800 hrs., I observed a large male come up onto a large flat rock + chase a smaller male off the rock (in two spurts). ~ 2 seconds later the smaller male came back + chased the larger fish off the rock. Repeated.

CJJ 68-6

1000 hrs. - Count 35 fish active (20 in So. half - 6 at meter)
Est. 60-65 active

Light $i = 13.8$
$r = 8.1$

Activity as before - feeding still (chasing perhaps somewhat increased)

two fish seen at water surface

Fish Planaria activity still decreasing - 7 on rock now
Young seen in tan area - ~2' deep.

Note - very low snail population.
(would not notice w/out careful looking)

Seems to be a good small juvenile & young population.

Note - Chasing when first seen was only tokenary. Now, chasing seems to be in earnest, but as yet I have seen no actual spawning. All the chasing I have observed so far (and it has been considerable - 1000-1030) has been follow for a few feet and then male lose interest or circle a couple of times and then lose interest.
Pairs easily broken when contact another fish

1035 - I am sitting up on one of the higher rocks & have just seen one pair that swam for several feet over the NE sloping rock of

the upper shelf and were in close enough proximity to have been spawning - but spawning not obvious. A third individual was encountered but this did not break up the pair.

Fish: Chase, feed (intermittent now), chase.

1050 - Count 40 fish on shelf - 20 in so. half
Estimate 65 " " 7 at meter

Most are very active (chasing)

Two planaria on rock

Light $i = 13.8$
$r = 8.2$

One pair observed spawning on NE sloping rock. They were interrupted by another male who followed the ♀. Then the first male followed him until the second male gave up & the first male resumed the chase.

In Cage - much chasing.
Can see 5-6 in one minute period.

1100 - Water level = 1.96

1155 - Count 51 fish on shelf - 29 in so. half
Estimate 75 " " " 7 at meter
feeding now

Most fish on shelf are chasing (can count fish in 2's) & spawning.

CSS 88-6

1200 hr. – Sun starting to fall on shelf

Very common to see 2♂ fighting over a ♀

~~Baby~~ Juvenile seen in cage!

Will investigate further day after tomorrow.

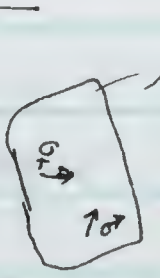
I was watching the chasing in the cage (hoping to see spawning) when I saw one young move on a light rock.

Est. 12 mm long – Last check was 2 wks ago & then saw no young.

Sun will shine directly on almost all of upper shelf.

Spawning behavior notes – On a big flat rock near the cage, I saw two adult fish (darker & larger one proved to be male). I did not see them from the first moments of their encounter, but from when I looked –

female & male as shown



the female moved slightly toward the male & then turned left slightly & stopped. Male approached & they swam w/ ♀ in lead toward the NE sloping rock ~6' away

COT 68-6

♀ did not try to "run" away from the male. Spawned twice (♂ pressing the ♀ down into a little crevice in the rock) and then they were interrupted by another male. Males circled & "bumped" into the ♀ who waited a few seconds, & they swam a distance with one of the two males & spawned again (other male followed). Then males conflicted again — then one again swims w/ ♀ & out of sight.

♂'s approx. same size.

Cage — all six seen in one minute period. Light just now beginning to touch the cage.

1250 — Count 18 fish on shelf (5 in shade at meter)

Light $i = 16.0$
$r = 11.4$

But because of oncoming front, no long length of time at this intensity / the activity visually fluctuates w/ cloud shading.

Now (3 minutes later — count 33)

Light $i = 14.8$
$r = 9.0$

Fluctuating numbers — Est. 35-45 fish
At times, seems as though one can see many of the fish move into shaded areas when direct sunlight peeks through clouds.

Still some (but little) feeding.
↑ by those not chasing

Much chasing
1 Planaria on rock

Very variable light (quickly moving heavy scattered clouds)

1400 (Random measurements of activity at various light intensities & times of length of duration of light intensity:

Direct light $\bar{i} = 15.2$
$\bar{r} = 11.1$

After 2 min – count 38 fish active on shelf
5 " " 25

Direct light · $\bar{i} = 15.5$
$\bar{r} = 12.0$
for ~5 min – then count 9 on NE rock

Direct light $\bar{i} = 15.7$
$\bar{r} = 11.8$
Indirect light $\bar{i} = 15.4$
$\bar{r} = 11.3$
} taken w/in 30 seconds of each other
& 49 counted on shelf
feeding
quite a bit of chasing

Water level = 1.96

CJJ 8-6

Direct Light i = 15.1
^ = 11.1

At initiation of direct light, 12 fish on NE slope

fish move quickly & are very active

3 min. later - 9 fish on NE slope
5 " " - 8
7 " " - 10

1415 - Count 46 fish on the shelf (22 on so. half
2 at meter

Sun rapidly going off shelf
1410 - 1430

Ex 6 5-70

Fish primarily feeding - some chasing
Scum somewhat heavier (bubbles)

1435 - No planaria or beetle activity

clouds

Count 62 fish - 29 in so. half of shelf
fairly heavy scum - hard to see "milky thickening"

Light i = 14.4
^ - 9.0

Only one young in cage. (*a very active young)

1445 - Extensive feeding & not much motion on shelf but mainly chasing in cage
much motion in cage (over 4 fish in one mass)

1450 - Spawning in cage observed? if so, spawn on cage bottom

@JJ 68-6

1450 — I cannot see a chasing pair on the shelf - all feeding.

But not one of the cage fish is feeding - all very actively chasing (several ♂ per ♀).

Scum is extremely thick (if it is coagulated, it is light green) at so. half of shelf now. It won't "fall" when touched or break - like oil. Mucky brown deposit on rocks at water level. Scum is thinner at northern half of shelf + none over most of deep water - (I just captured by hand one fish which was nibbling at the scum - an adult ♂ in good blue-black coloration.)

1500 hrs. — Count 62 fish active on shelf

20 in so. half + 3 at meter

hard to see

Estimate 100 fish on shelf

Light i = 14.2
r = 9.0

6 planaria on rock

Observations

In cage, pair were swimming together + were intercepted and followed by two more males. They mingled under a rock for a second and then two of the male fought (round + round in a circle) while the female + one

for ~ 1/2 sec. (unusually long time?)

males went on their way together.

1520 hrs. – In cage, many if not spawns, at least attempts to spawn by males with both females – often 3 males with one ♀ + one ♂ with the other ♀.

1530 hrs. – Count 74 fish on shelf
35 on NE sloping rock
50 in northern half
Extremely hard to see southern half.

Est. 125 on shelf
Feeding
Some chasing + Spawning

Light i = 14.3
r = 8.9

Terribly hard to see through scum in so. half of shelf.

1600 hrs. – Count 38 fish on NE sloping rock
Cannot see rest of shelf adequately to count but guess that # of shelf is approx. the same as previously – ~125 fish on shelf

Light i = 14.3
r = 8.8 ← typical of so. half only
(in no. half – no dense scum)

Water level = 1.97

CJJ
68-6

1300 hrs.
3 OK I took three pictures of the shelf + scum
1600 hrs. with my camera.

I can see fish come near to the surface under this thick oily scum.
No scum at all over deep water -
Suppose this scum is just normal scum pushed together? Perhaps not - this scum is oily.

1615 hrs. - Count 64 in northern half now. I would guess that there are fewer in the so. half of the shelf
Est. 130 fish on shelf.

1620 hrs - ~ 35 fish on NE slope

Light $i = 13.9$
$r = 8.2$ R over dense scum

1625 - Count 75 fish on whole shelf - not enough to reflect correct count. visibility
Vision very impaired.

Est. 100 - 125
Feeding
Little chasing

9 Klamath on rock
Wind stronger → 20 mph down here

CJJ 68-6

1725 – Scum condition as before

Water level 1.96

Light i = 11.8
λ = 6.8

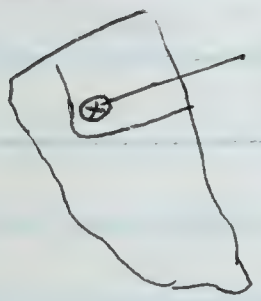
Count **52** in north half of shelf – 36 on NE sloping rock
Estimate 100-125 fish on shelf
Mainly feeding activity
15 Planaria on rock

1745 hrs. – Three fish visible as active in cage – still some chasing (not in total earnest)

Intensive feeding on NE slope + shelf

1750 hrs. – Count 45 fish on NE shelf (going over ledge?)

Light i = 11.0
λ = 5.7



1800 hrs. – Count 72 fish total on shelf
(scum not as thick – can see fairly well)
20 in SO. half
37 on NE rock & going over ledge

Light i = 8.7
λ = 3.5

CJJ 68-6

1805 - Sunset

1815 - Count 27 fish on NE sloping rock

Total count 56 fish on shelf

Light $i = 6.5$
$r = \sim 1.0$

1830 - Count 39 fish on shelf
23 of these on NE slope
(still feeding ?)

~ 40 Planaria on rock

Casual Experiment w/ reaction of fish to flashlight beam:

5 juvenile + 4 young fish left beam in 5 sec. or less
(2 left immediately)
1 juvenile moved but did not leave light in 20 sec.
1 juvenile - took 9 sec. to move
1 large juv. - " 14 " " "

1850 hrs. - Count w/ flashlight ~~25~~ Est. 35 adults on shelf. Good count - now almost dispersed scum. Very little movement of fish - v. little activity. (some hide in rocks)

Water level = 1.95 on scale
75 Planarians - beetles becoming active.

1855 hrs. - left.

CJJ 68-11

Carol J. James

See CJJ 68-12 for # of fish in trap at lower shelf. – 12 fish

Devil's Hole, DVNM, Ash Meadows, Nye Co., Nevada

14 June 1968 0500 – 2015 DST hrs.

C. James & C. W. Loy

Daylight Survey

Stopped at Manse & put in traps. Charlie will leave sometime this afternoon to clip fish for his daylight survey at Manse Sunday (16 June) & put fish in his cage in Manse.

Initial Observations:

Gusty during day

Weather – no wind; sky clear

Just started getting light as we arrived. Sunrise not until after 0530.

Condition – Algae & spirogyra on shelf dense.

Floating algae at SW edge.

Scum heavy and broken only in southern half of shelf.

See CJJ 68-12 for pictures

We put a 12 × 12 × 30" bottomless cage in the water just in front of the observation rock. It consists of a wooden frame lined with fine mesh screen and having a ring of sponge rubber at the bottom frame. The purpose of this was to help in indicating the number of fish using shelf rocks to hide in during darkness. The frame was to be placed on the shelf during darkness and the sponge rubber used to go between rocks to prevent movement in and out under the frame. Unfortunately, some activity had started before placement of the frame at 0505 hrs. –

but the greatest increase in activity occurred after placement. ~20-25 active on so. half of shelf.

Light was not significant on the light meter and a flashlight was necessary for placement, but the shelf was grossly visible (some light was present - first light). I held the frame at the top of the water until the sponge rubber was soaked, and then placed it and we attempted to seal the frame as well as possible - using a rod to push the foam rubber between rocks. We did not enter the water. Flashlights + movement probably disturbed fish. One large adult + one young visible after placement.

Frame not placed when dark enough, probably not large enough, + may not be completely sealed at bottom.

Light increases very quickly - 0500 - 0530 hrs. and during this time # of beetles visible at water's edge decreases quickly, planarians may decrease somewhat, + C. diabolis activity increases markedly.

0515 hrs. - Light i = 6 light meter used
r = 2

As usual - All counts & Estimates are based on individuals as or larger than large juvenile - small juv. + young are not included.

Count 71 in so. half of shelf ! Northern half hard to count because of distance, scum, dense algae + spirogyra. can count only those I can see moving. Count 12. But I'm sure there are more.
Est. 100-130 active on shelf.
Count 10 active in cage.
many Beetles at water's edge. Planaria abundant + active

CJJ 68-11

0600 hrs. – Light $i = 10.8$
$r = 5.2$

Counts do not include those seen in cage unless noted

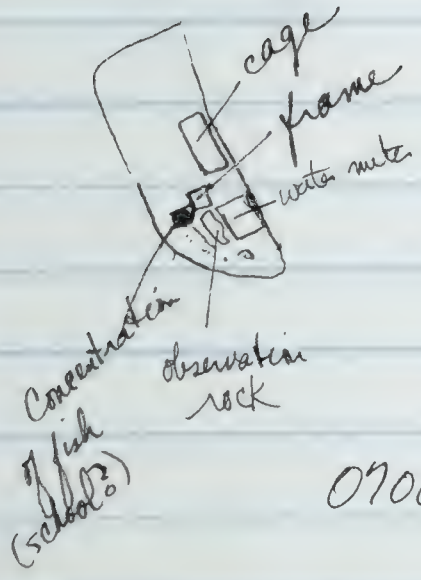
Count 69 on so. half of shelf –
Total count 82 on upper shelf (hard to see no. half) ∴ Estimate 120 on shelf.

9 fish visible in cage – algae dense + dark in cage + scum heavy.

I had to use a flashlight to count (especially when counting fish over algae or spirogyra) and I noticed a very definite and quick negative reaction to the light beam – very fast dart away from the beam.

Feeding frequent. Some chasing and much "swimming around."

I also noted that there seemed to be a preponderance of fish just at the NW corner (x W side) of the observation rock. Some schooling. ~ 20 fish congregated in approx. zone sq. ft. area.



0700 hrs. – Light $i = 11.1$
$r = 6.5$

Count 68 on shelf now – 55 in so. half
Scum heavier, however, may have influenced count.
Still very negatively reactive to light beam which is necessary over dark shelf areas.

See CJJ 67-12 for count of actual # in cage

Count 7 in frame now. (small young not seen but counted)
Watched cage for several minutes and could only see 2 fish active. Est. 100

Water level 2.00

Still congregate at NW corner of observation rock, as previously noted - congregate in open area mostly.
& where spirogyra & algae most sparse.

0830 hrs. - Count 21 fish on shelf - 14 in ~~30~~ half. Scum heavy, but very definite decline in activity. Estimate 50 fish active. - Perhaps less.

Light. i = 12.5
r = 7.2

Count 9 fish in frame - evidently not sealed. I removed the frame from the water.

Count 2 visible as active in cage.

Water level 2.00

0845 - Now count 45 fish on shelf 36 or so. half.
(after dispersing scum somewhat & removing frame w/ 9 fish in it -)
Est. 50 fish active on shelf. Activity now mainly swimming.

CJJ
68-11

Fish hid in rocks + spirogyra while I dispersed scum. They did not reappear in numbers until about 15-20 sec. after I had stopped.

Very little beetle activity.
Planarian activity also low.

1000 hrs. - Light $i = 12.8$
$r = 7.5$

Some (1 or 2) fish seen at surface

Count 29 fish on shelf - 18 in so. half. Hard to see because of scum + dark background
Estimate 50-60 fish active on shelf.

malformity

Observed a young - ~ 6 mm
Observed a S-shaped spine + constricted caudal region on a fish ~ 17 mm long (♂ ? ♀).

Water level 1.98

In cage - at first only one fish seen, then after a minute observing, two pairs of fish swam down the bottom of the cage (north to south along the eastern side) both pairs were adults - one pair was of the original adults (large) the other pair was somewhat smaller.

1130 hrs. – So far only one fish seen around water meter.

Light i = 13.8
∧ = 8.0

Direct sunlight not yet on shelf – ~ 5 ft. above water level on west slope

Count 47 on shelf – 26 of these in the so. half. Some feeding. Some chasing. Estimate 70-80 active on shelf.

8-10 fish active in cage.

Observed one very large fish (28–30 mm) moving over the shelf randomly but always at the bottom. Finally went into one of holes in water meter + I did not see it come out.

1150 hrs. – Water level – 1.93

Several 5-7 mm young seen

1205 hrs. – Direct sunlight just touches shelf. (so. western side.

1300 hrs. – Light i = 16.0 +
∧ = 13.2

Direct sunlight on western 2/3 of shelf.

Count varies 26 - 36 on shelf
(half in so. half) ~ 10 of 36 in so. half

CJJ 68-11

Est. 50+ fish active

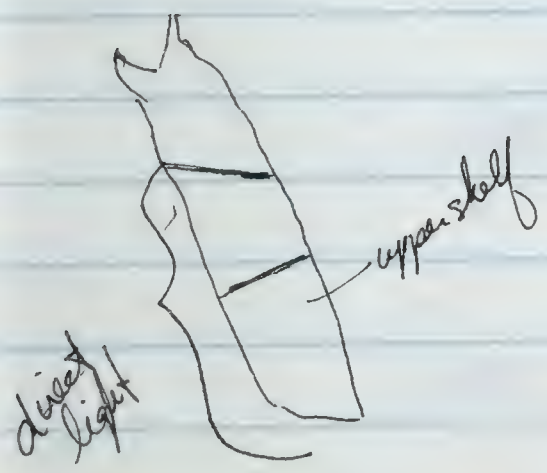
Count is difficult because of extremely quick movements of fish - continuous motion + darting. Some feeding but mostly chasing. No spawning actually observed as yet.

Bubbles given off by algae + spirogyra

An unusually high proportion of those counted frequent the western side of the shelf against the western ledge (shade is available in many areas on this ledge).

Scum still heavy + becoming oily in extreme southern end.
Cage fish also very active, even though sun not yet completely on it - direct light only on western ¼.

14/10 hrs. - Light $i = 15.5$ $r = 12.5$ Light direct on all of shelf



Count 47 fish on shelf
14 in so. half.
many on NE sloping rock.
Estimate 60-65 fish on shelf

Motion Activity still intense - quick + continuous movement. Much chasing. (one group of 6 fish chasing) Feeding also observed, but mainly on NE sloping rock.

In cage - 12 fish active - chasing + attempted spawning observed + several

CJJ 68-11

young seen. Mat of algae in north portion of cage hinders vision of cage fish because it provides such a dark background.

Note Relatively few fish in southern portion of shelf - even w/out disturbance.

1515 hrs. - Count 53 on upper shelf.
20 in so. half + 24 on NE sloping rock (many of these 24 are juveniles

Est. 80 active on shelf

Still much motion. Chasing frequent. Some feeding.

seems to be more young juveniles + adults than before

Shade just beginning to fall on western side of shelf.

11 individuals seen in cage - adult very actively chasing. Spawning observed ?!

Light $i = 14.7$
$\lambda = 11.8$

Water level 1.89

1600 hrs. - Sun completely off shelf.

Est. 95 active on shelf

Count 69 on shelf - 26 of which are on the NE sloping rock + 30 of which are visible in the so. half of the shelf. The so. half is hard to see now because

of the oily scum over most of it. Polaroid Sunglasses enable me to see the NE sloping rock quite well. Most of fish on rock are small adults & large juveniles. Larger adults seem most often to prefer deeper channels.

Light $i = 13.2$ $r = 7.9$ no direct sun

Still much movement on shelf but not quite so quick. - same in cage.

9 fish visible in cage.

Water level 1.92

1630 hrs. - Much feeding. Chasing is very limited. Up to 10 fish at a time feeding at surface.

Light $i = 13.0$ $r = 7.8$

1730 hrs. - Count 83 on shelf - 38 in southern half but difficult to get an accurate count in this half because of heavy oily scum. Est. 130-150 active on shelf.
Again → 10 feeding at surface at one time.

Activity now almost entirely feeding. Intensive feeding & movements are no longer quick.

No significant beetle or planaria activity
↑
some activity

1730 - Light i = 12.5
r = 7.1

Young & small juvenile seem to be unusually abundant along water's edge at rocks & western ledge - I can count 10 of these now and although I noticed some indication of this at about 0700 hrs., it is even more prominent now.

As noted sometime before, there is a preponderence of fish - especially of adult fish at the SW portion of the NE sloping rock, without 15-18 fish in a 1x1 ft. area.

Average of 11 in the area at one time.

Only a very few insects dead in the water
(flower fly & 2 white narrow-winged moth)
↖ on top of algae

1745 - Mill - feeding

Although the frame (bottomless cage) did not this time prove successful in determining movement, it should be noted that 9 adults were in

(JJ 68-11

the frame when I removed it — Could it (& incomplete sealing between rocks) be a good capture trap ? Evidently the fish move under the frame & into the trap area by going through passages in & between rocks — but they frequented the sides & edges of the frame once in it — ∴ not readily being able to leave the frame. This may not work when left overnight, however, for retreat to the rocks would aid escape until the next morning when more fish (hopefully) would enter.

Before I leave, I will set the frame up (unsealed) at the bottom & leave it until Sunday to evaluate it further

1500 hrs. — Still 5-10 young & small juveniles at waters edge at western ledge.

Count as many as 20 fish near waters surface over NE sloping rock & near cage. But only briefly. Milling.

1850 hrs. — 94 counted on shelf - 33 in so. half.

So. half remains hard to see because of oily scum, but I believe this count to be fairly accurate & at least relative since distance is a factor in count of those on the no. half.

Oily scum making so. half darker ?!

10-15 still at surface in so. half.
Feeding predominates. But increasing milling & some shoaling.

Estimate 160 FTO on shelf

Light $i = 11.8$
$\lambda = 6.2$

Water level – 2.02

2000 hrs. – 63 fish counted on upper shelf – 75
20 in southern half.
75 estimated activity over entire shelf
Fairly accurate count – flashlight used. Most fish slowly milling or quite little feeding or chasing.

Light $i = 8.1$
$\lambda = 3.2$

Water level – 2.06

Planaria + beetle activity increasing
Beetles at water's edge.

Fish movement markedly decreased as a rule

(5) 5–6 mm young seen w/ others at western edge of water (as noted before)

React negatively to beam from flashlight

~~EB~~ 2025

Light 4.7

16 counted active on shelf – 8 of these on NE slope where they are exposed
Estimate 25 active on shelf

CJ 68-11

Every other area of the shelf, has rocks & heavy spirogyra — fish hide easily & few are active.

Still can see several young near water's edge —

Not more than 2 fish congregated around water meter at any one time during the day.

Scum still persist.

2030 hrs. - Light i = 2.5

Count 9 fish "active" (visible) on shelf - 5 of 9 on NE slope. 15-20 on shelf.

There may well be others, however, in the no. half of the shelf — on the NE sloping rock. But if so they are not adults & are not moving.

Put frame in water to test usage as trapping device — unsealed

Water level - 2.08

left. 2045 hrs

CJJ 68-17

Carol J. James

Devil's Hole, DVNM, Ash Meadows, Nye Co., Nevada

12 August 1968

0600- 2015 PDST

Daylight Survey

C. James & C.W. Ivy

After rainstorms and clouds prevalent in the Las Vegas Valley for the past several weeks, we noted rather drastic wash-out effects at Devil's Hole (roads too!! do also show such effects).

It was much more difficult climbing down into the hole than normal because of gouged sections in some places and piles of rocks in others. We were very impressed at the amount, & size of debris (mainly rock) that was moved.

The water area was also much changed. Although there was some spirogyra on the 4th shelf, it appeared to have been some that had grown back since the flood, and evidently most or all of the shelf had been covered by soil and rock debris.

Please note - Observation made during this survey are somewhat limited because of the (second and newly introduced) floating sectioned cage which floats over the northern (& especially N/E) section of the shelf - Also. Notes will be made on my next trip (w/in the next two days) as to possible dates of the flooding (possible use of the USGS water level recorder).

Also see notes of the next trip for counts & measurements of cage fish.

a little out of proportion, but indicative of area filled w/ soil + rock debris.

The flooding cage appears to be OK, flooding normally - at least now. But the original cage has significant rock debris in it and is no longer propped up. At its NW corner, the water level is now only ~ 1 inch below the top of the inside cage. Water meter level 2.00

Especially at time of flooding, the water level very probably exceeded that of the lowered cage and may have resulted in exiting or

entrance of fish. I have looked only for a few minutes (time of writing this: 0645 - 0730) but I have only seen one large adult fish and one or two small ones in the original cage. I must note here that normally during even a slight rain or slight disturbance at the water's surface, the fish immediately take cover under rocks or at the lower shelf levels. Therefore it is possible that exchange between the cage and the shelf was nonexistant-at least at the time of flooding. However, soil and rock debris may have had a significant effect on the cage population, as it may also have had on the shelf population.

Much of the shelf (cage) is dark and difficult to observe. fish or because of a dark grey "soot". This evidently covers almost all the shelf and rocks (layer is ~ 1/4" thick)* and is in some places covered itself by a light tan layer of soil or sand. Rock debris also covers much of the shelf, with really significant coverage as noted on the previous page and two piles on either side of the observation rock I use. - Both piles reach surface. I must comment here that, especially if rain had been falling for any length of time before the flood occurred, major effects were on juvenile and young (esp. eggs) because of their habits of frequenting rock surfaces, which were very effectively smothered with (up to inches of) soil in most instances.

Please see next page of next trip

Scum fairly heavy. Weather - changeable -
Dark clouds around "hole".
Partly cloudy. Wind - gentle to gusty

* I cannot test all areas of the shelf until next trip, but the dark grey layer appears to be 1/2" thick in many places (may be thicker) and the sand layer varies to several inches.

CJJ 68-17

0600 hrs. - Light $i = 8.2$
$r = 3.7$

Fish very actively moving.

Count 130, est 160 in so. half of upper shelf only

I cannot see the northern half because of insufficient light, relatively heavy scum, and dark grey background.
Est. 250 - 280 active on upper shelf.

Most fish visible now are small & medium - sized (6 - 20 mm) adults. Juveniles are not prevalent but may be because of the morning light or the dark background.

Much movement - constant activity.

0630 hrs. - O_2 taken (Winkler) 2.7 ppm.
+ (Because of reduced spirogyra, conditions now may resemble those typical of productivity during late October normally)

0730 hrs. - Feeding activity

0800 hrs - Still much feeding.

Count 4/9 on so. half of shelf but reflection off scum hinders vision slightly. Est. 75-80 on so. half.
150 on shelf.

Sectioned cage prevents view

0820 hrs. - Light $i = 13.6$
$r = 8.2$

CJJ 68-17

0830 hrs. - O_2 taken - 2.8 ppm

One adult ~22 mm malformity seen - S-shaped spine

No young & only two small juveniles observed to this point.

1020 hrs. - Count 36 or so. half of shelf.
Est. 60 or so. half. Est. 100-120 on shelf.
Scum reflects much light. Somewhat hard to see
Still majority are small medium-sized (16-20 mm)
adults. Only 2 large juvenile seen

3 fish seen in cage - 2 adults - one large juvenile.

Activity - feeding, some chasing.

Light. $i = 14.7$
$\lambda = 8.8$

One fish observed to lie lying perfectly still on substrate - no fins moving

1030 hrs. - O_2 taken - 2.6 ppm

1035 hrs. - I have just seen two young fish - ~ 9-10 mm long. These were observed at the extreme southern end of the shelf (as shown on page 2) which is partially dammed by the rock piles and in which there is very good spirogyra

growth but no soil debris — rocks here remain bare of soil. Evidently, this 2x1' area was relatively undisturbed by the flood. Even though it looks like it would be a drainage area, all evidence indicates drainage ~ 4' west of the major ditch.

1220 hrs. — Scum becoming oily and hard to see through.
Count 29 fish in south half of shelf.
Est. 50 " " "
Est., then ~100 fish on shelf.

1230 hrs. — O_2 taken — 3.1 ppm

Light $i = 15.3$
$\lambda = 10.6$

I entered the water to raise the cage. I observed several young on the shelf. The population in the original cage seems to have decreased. I found a large rock in cage section II and upon examining it quickly, noted only one fish in that cage (formerly two). At quick glance, I noted that almost all adults were doing fine (did not look at Sections 1 - 5). See next trip.

The dark grey "soot" is silty and sometimes spongy - could it be decaying Spirogyra (covered with dirt from the flood)? Also, please note the similarity in appearance to the "grey matter" I refled to last summer - and so I got out of the water, fish followed

CJS 68-17

areas where I had turned up the grey matter? and pecked - feeding on it as noted last summer.

Sun first on shelf - 1240 hrs.

Also, H_2S bubbles (noted before but only in minute quantities) came up with every step on the dark grey material.
Scum is green. Algae & scum beginning to bubble.

1430 hrs. - Count 19 fish of all sizes (mainly medium-sized & large adults) on so. half of shelf.
Est. 35 on so. half —
Shelf in full sun and has been so for over an hour. Sectioned cage provides shade but I cannot see what effect this has on the fish.
Overall estimate of fish active on shelf - not allowing for concentration under shade of cage — 60-75 fish.

Scum is fairly oily - esp. at so. end.
Many tiny bubbles on surface and tiny popping noise is everywhere. Occasionally, there is a large bubble that comes to the surface. (½" in dia)
There are also 20-30 groups of yellow-green bubbles at the surface, especially at the southern end.

Earnest chasing seen in the cage.

CJJ 68-17

2 small juveniles seen.
Fish seem to have retreated back from area immediately to my left and in front of me. It may not mean anything, but most of the fish visible now are to the west of the original cage - where I stirred up the grey matter. Much feeding.

Small mats of algae float to surface - these are numerous now.

Light i = 15.1 Full sun with cloud last
r = 12.1 these light readings hold true no matter where I move the light meter over the water's surface - as long as I keep it in sunlight, of course.

1/30 hr

O_2 taken - 3.0 ppm

As noted in previous trips, the small snails are not conspicuous - in fact I cannot readily find one now - because of the covering debris, I suppose. I feel that their population is at a low point during the summer, anyway - But perhaps (because of the spirogyra) it is just that they are not conspicuous now. (summer)

CJJ 68-17

1615 hrs. - Direct Light completely off shelf
Scum is very heavy and oily.

Count 32 fish at surface - feeding.
Most are small adults, but w/ some large adults and large juveniles.
31 fish on or near bottom. Also feeding.
Est. 85 fish on so. half of shelf
Est. 150 ~~90~~ fish on shelf.

Intensive feeding at surface + grey areas.
No apparent size segregation.

Light $i = 14.1$
$\lambda = 10.0$

1630 hrs. - O_2 taken - 2.0 ppm

Juveniles (5-6 seen) apparently more numerous than this morning.

1750 hrs. - 30 fish on surface of so. half
37 on or near bottom
of these, 13 are juveniles - noticeable difference in activity from rest of day
Est. 90 in so. half.

Intensive feeding still

Although I cannot see the no. half of the shelf well, I can see 20 fish at the surface.
Est. 160 on shelf.

CJS 68-17

10

Light i = 13.0

r = 7.9

Peak of activity + # on shelf between 1630 + 1750 hrs.?

Comment on change of shelf appearance —

It is very noticeable that the shelf has changed from its morning appearance, an observation I have noted before but was uncertain as to truth. Now the dark grey areas have been replaced by light tan, and the amount of spirogyra has increased markedly. Even those areas I thoroughly disturbed early this afternoon and left entirely grey are now fairly green. The same is true of almost all areas of the shelf — Indeed, the spirogyra is still scattered and thin, but there is markedly more of it. Floating algae is much more frequent also. (Before, one large patch; now, several other smaller ones)

The original cage has more spirogyra in it than I've ever seen in it. The sections of the floating cage also have quite a bit of spirogyra in them.

I wonder if the flood happened only a few days ago and this is recovery of the spirogyra, or if this is more an indicator of greenness increasing during the day and after full sunlight on the shelf.

1830 — O_2 taken — 5.0 ppm

CJJ 68-17

1840 hrs. - Only a max. of 20 fish now at surface on so. half of shelf. 30 ± in NE section of shelf - at surface

where the sectioned cage isn't taking up the surface now.

Beetles become active (slightly

1855 hrs. - Now ~ 25 on surface at no. half
~ 20 " " " so. "
140 on shelf

Nearly a third of the fish on the so. half (count 55 - est. 75 fish) are juveniles

Correction — momentarily, it appeared so, but not now — most are adults, but there are ~15 juveniles easily visible (also one or two young).

The cage must be raised again - the water level is quite high 2.06 on the meter scale. and it is again very easy to imagine exchange w/ the shelf — adults on the surface outside and one adult inside the cage is circling the northern end at the surface.

1930 - 31 fish visible at surface on northern half of shelf. (adults)
21 fish visible at surface on so. half.
Count 32 fish at bottom on so. half of shelf —
~ 12 of which are juveniles.

~110 at. on shelf

Proportion of juveniles seems to be increasing. (Adults going off shelf?)

CJJ 68-17

1930 hrs. – Light $i = 9.2$

$r = 5.0$

2000hrs Light $i = 2.5$

$r = 0$

14 fish counted on south half of shelf
7 are juveniles and one young
est. 35-40 on shelf

2000 hrs. – O_2 taken 4.3 ppm

Left 2015 PDT – Big cage raised further
Screen ¼" from water level was
raised to ~ 2".

CJJ 68-21

Carol J. James

Devil's Hole, DVNM, Ash Meadows, Nye Co., Nevada.

21 October 1968 0730 - 1830 hrs. PDT

Daylight Survey

Carol James

I stopped at Manse Ranch Spring and put in ten traps.
Traps in 0645 - started getting light at 0650 hrs.

Arrived Devil's Hole 0730 hrs.

General Observations -

Weather - No clouds - only very slight to no breeze. Pleasant temp.
(0845 - air temp. = 18°C)

Shelf Condition - Algae mats are very dark grey, almost black. Spirogyra is only wispy covering over some rocks & silt areas - definitely less than 6 Oct. (no pictures - see 1-2 Nov.)

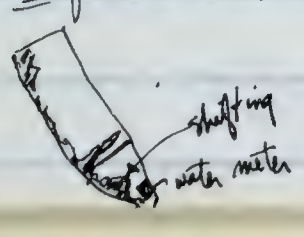
Spirogyra

upper shelf

Spirogyra in cage much thicker than on shelf - lining much of sides and bottom of cage - but again not as much there as was 6 Oct.

Shelf appear light tan in some silt areas - Dark grey in others (depending upon depth of sand over spirogyra?)

all of water area - DH.



Scum - very broken and much reduced shifting over shelf

CJS
68-21

Visibility is very good.

0745 hrs. Light incidence - 9.7
reflected - 5.8

North half of upper shelf - Count 33 fish
South " - Count 48 fish

Est. ~ 100 fish on shelf. (Good visibility

Fish of all sizes - incl 3-4 small juvenile + 1 yearling.

(Water level - 1.90 on meter)
Snails apparent as on beetles

Intensive feeding - much searching (blood-hound fashion, with nose to ground & bodies at about a 45-60° angle to ground) + then nibbling - especially over silt areas.
At Base small rocks directly in front of me - not much feeding but some milling-searching behavior.

One fish was seen furrowing into the silt, but then he came to a halt and just remained, half-buried in the silt motionless for ~ 10 seconds.

0810 - O_2 taken (Winkler method) - 10 ppm.

Fish still feeding - not flashing + flipping as much as observed 6 Oct 1968.

CJJ
68-21

1045 hrs. - Light $i = 12.8$
$r = 7.2$

Scum as before
Spirogyra darker now - forming dark & heavier lace patterns over silt areas.

Fish - so. half of upper shelf count 52
no. " " " " 18
Estimate less than previously
~ 85-90

Still feeding, although perhaps not as intently as at 800 hrs. Feeding on light tan substrate directly north of rock on which I'm standing & on rocks. Almost no fish feeding now over areas where algae is forming patterns & getting heavier (through day). Up to 20 fish were counted feeding in the deep western silt area of the shelf - now count there is only 3-4 in algae areas.
↑ usually - but (may be more)

1115 hrs. - O_2 taken 13.8 ppm

1330 hrs. - Light $i = 12.8$
$r = 7.8$

Direct Sunlight just beginning to shine on water - not on shelf yet, only NW section over deep area.

CJJ
68.21

Bees active.

Because of reflection of light + the scum (shifted over so. half of upper shelf) I cannot see really clearly. But there has been a very definite reduction in both # of fish visible + in activity —

Count 29 fish in so. half of upper shelf
" 14 " " no. "
Estimate ~~so.~~ ≈60 fish active + visible on upper shelf.

Water level low on cage.

Careful entry + movements in the water were made so that I could take measurements of the fish in the cage. Also, I collected some substrate for microscopic examination. I attempted collection of ♀ fish for a reproductive sample.
→ 6 Fish were collected + preserved in Formaldehyde

The sunlight hit the upper shelf for the first time today at 1400 hrs. (NW corner)

1430 - Full sun on lower depths. Sunlight still only on NW corner of upper shelf

Cage Fish

♀ - 17, 17, 19, 20, 22, 23, 23, 26, 26 mm (S-shaped)
♂ - 23 mm

Temperature of water at both end of shelf taken w/ Mercury Thermometer - 34°C.

CJJ 68-21

1430hrs. - O_2 taken

Light i = 12.6
r = 9.1

Sunlight now hitting on most of western 1/3 of upper shelf - Observation plank at fence interrupts

1450hrs — Light i = 13.6
r = 8.3

Band of Direct sunlight isn't wide enough to cover whole shelf at once - but it is traveling fairly quickly over the shelf - not reaching the extreme east side shaded by the southern rocks + water meter.

Note light reading above -
Even with my disturbance. (Have been out of the water ~ 1/2 hr.) the fish should have resumed activity now.
Count on entire shelf (w/ sunlight, visibility is very good + scum is extremely broken - spread

CJJ 6-21

over the whole water's surface & especially reduced over the upper shelf) is 15 fish! (most are adults) Activity reduced somewhat. Striking absence of fish. Perhaps 30 fish active on shelf! 20-30

1455 - sunlight going off shelf. Now shining in cage where heaviest spirogyra is present - NE corner.

1505 - Sunlight off shelf.

1605 - So half of upper shelf - count 39 fish
No. 1 " " 23 fish
Fairly Good visibility (getting hard to see fish against dark background)
Estimate 80 fish active on shelf. All sizes.
Some feeding - mostly searching or milling behavior. But not a great deal of movement.

Beetles - Coming back on rocks at water's surface
(0800 - at surface on rocks
1100 - Beetles + planaria on bottom)

Just a few sq. inches of floating algae clinging to western edge.

1610 - Light $i = 12.2$
$\lambda = 6.9$

More small juv. ~~3~~ 2 young seen now than this morning.

1615 - O_2 taken 8.1 ppm.

CJJ
8-21

1620 - So. half of upper shelf - count 39 fish.
No. " " 30 fish
Estimate 85 fish

Feeding activity - intense flying

1635 - Est. 95-100 fish active

1705 - Count (so half) - 31
(no. half) - 25 fish

Est. 75

significant # of juveniles.

Note - fish harder to catch now - as during last fall + winter.
Only ≡ (# varies w/ time, but a max. of 10 large adults) large adults visible - almost all are small adults + juveniles

Feeding.

1710 hrs. - Light - $i = 11.5$
$r = 6.0$

A male ~22 mm seen chasing a large, heavy-bodied ♀ (~26 mm). He followed her for several feet, encountered & circled with another ♂, then followed the ♀ again for ~ 1 ft + she gave a sudden 90° turn w/ a burst of speed + he stopped following her. Male appeared dark blue in color.

note: Could this proportion of large adults to smaller fish

CJJ 68-21

be more indicative of the true population than what was seen this morning?
Could it be that the larger adults feed primarily during the morning hours & restrict movement (& ∴ visibility) of juveniles, which then are prominent during the afternoon? Such a population structure (few large adults) would seem to imply a die-off of large adults during the last two months. This has not been reflected in the cage, which has only adult fish — but the rather heavy spirogyra growth in the cage is not at all typical of the nearly barren shelf, either.

Just from observation, I feel that the population is a healthy one, with many juveniles & small adults (& one or two young), but with not as many (proportionally or numerically) large adults (~22+ mm) as I would expect from August observations.

Time of day collections are made may influence results.

Most young to ~8-9 mm — ~~not~~ smaller. One young ~6 mm seen ±

Some chasing by adults — chasing smaller fish out of feeding areas.

'Plowing' — small adult 'plowing' body into silt & making somewhat of a furrow — really stirring silt up.

CJJ
6/8/21

1735 hrs. - now count ca. half of shelf - 39 fish
(most are juveniles)

Entire shelf - est. 85 fish
Have observed some adults going down over upper shelf ledge.

Large adult ~27 mm has been observed feeding on one of the large rocks w/ spirogyra on it. - Seems to have been feeding there for several hours.

Small juveniles increasingly apparent.

1740 hrs. - Light i = 10.8
r = 5.1

Count 58 fish on shelf
~ 17 of these are small juveniles or young
Only ~ 6 are good-sized adults (22+ mm)
Est. 75 on shelf
Intensive feeding

1800 hrs - Observed 6 young (~8 mm) w/in 5 minute time

Light i = 8.3
r = 3.7

Temp. of water by mercury-thermon = 34°C even in shallowest portion

42 fish visible on upper shelf -
NOT COUNTING YOUNG

~3 ~5-6 mm young seen
60 fish estimated to be on shelf

CJJ 8-21

Fish nibble at silt - then spit it out - commonly seen.

1810 hrs. - Big (~27 mm) fish mentioned previously (1735 hrs.) finally left rock + went down to silt substrate just nearby. It made what looked like a furrow + otherwise lunged + flipped in the substrate - evidently foraging for food. Stayed ~ 1 min. on silt (doing these maneuvers) + then went back to feeding on rock. It had as near to a 'territory' for feeding as I have seen, but this was more simply because of its size + the fact that it stayed almost all the time on the top of that large rock. It only occassionally challenged intruders.

1815 - The large fish has disappeared.

$i = 4.7$
$\lambda = \sim 1.0$

1820 hrs - O_2 taken = ___ ppm

Drastic drop in activity - both # visible + amt. of activity. No flashlight to count but would estimate ~ 40 fish visible on shelf. 10 seen in so. half w/out flashlight.

No estimate of young included.

Note - no actual spawning noted during the day, but I did not spend a great deal of time looking for some.